

The Determinants of Monetary Policy

Insights from 13 OECD member countries

Mads Berg



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Department of Economics
University of Oslo

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Forfatter: Mads Berg

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Summary

The importance of monetary policy is unchallenged in modern macroeconomics and its prominent place in the theoretical discourse is unchallenged. Economists have offered several attempts to define the determinants of monetary policy in order to offer an optimal solution to a complex problem. Some well known examples of this in the literature are the Friedman rule, the Taylor rule and most recently central bank independence and inflation targeting (Bernanke and Mishkin, 1997). The main goal in the recent decades for monetary policy has been to achieve low and stable prices by stabilizing inflation. However, research has shown that a strict adherence to this policy can potentially have a destabilizing effect on the economy. In addition to the goal of price stability, an increasing number of central banks are clear in announcing their attempt to stabilize output. These tandem goals of monetary policy are often referred to as flexible inflation targeting. According to Svensson (2002) there is a general agreement that this is how central banks in industrialized countries conduct their policy.

With the main goals of stabilizing inflation and the output in mind, this thesis aims to investigate how these goals determine monetary policy. How much emphasis does a central bank put on each of these goals, and has the relative importance of them changed over time? Furthermore, if a central bank put more emphasis on the main goal of stabilizing inflation, would this lead to more volatility of the output?

To address these questions, the thesis will compare the actual policy interest rate with the outcome of two simple policy rules for 13 OECD member countries between 1990 and 2005. The first policy rule is based on a strict inflation-targeting approach. Here the central bank only attempts to reach the inflation target in the short-term, so the policy interest rate is according to this. The second policy rule is based on the well-known Taylor rule (Taylor, 1993). This rule suggests that the central bank puts some weight on both inflation variability and output gap variability, making it a flexible inflation-targeting policy rule (Svensson, 2002). The policy interest rates and the output-gaps of the policy-rules will then be compared to the outcome of the actual policy represented in graphs. The outcome of the strict-inflation targeting rule is calculated for all 13 countries, but due to restrictions in the data set the Taylor policy-rule is only calculated for 7 of these countries.

The approach outlined for this paper poses some challenges in how to construct the policy rules. For the policy rules to be effectively compared to the actual policy, they will have to be

based on information that was available at the time when the central banks made their policy decisions. Knowing the exact information set of the central bank is out of the scope of this paper. In order to solve this problem, real-time data obtained from Consensus Economics Inc. (2010b) is used as forecast of the expected inflation with unchanged policy. The advantage with the data from Consensus Economics Inc. is that it is real-time and thus not revised ex post. These forecasts should be good proxies for the central bank forecasts, even if they are not likely to be identical.

The analysis implicates that monetary policy in the period between 1990 and 2005 appears to be best explained as following a flexible inflation-targeting approach. Comparing the actual policy with the two policy-rules shows that the Taylor-rule interest rate follows the actual interest relatively closely for the countries in the sample. The strict inflation-targeting rule is rather different from the actual monetary policy apart from when expected inflation is close to target. However, as the strict inflation-targeting rule exclusively focuses on controlling inflation the effect is an increase in output gap variability. Furthermore, the relative weight on the targets of the monetary policy appears to have shifted somewhat during the sample period, allowing for an increased focus on output stabilization.

The econometric estimations were conducted in PcGive, and all other calculations and graphs were compiled in Microsoft Excel.

Preface

First and foremost I would like to thank my supervisor, Steinar Holden, for insightful comments and useful guidance for the completion of this thesis.

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As this thesis marks the end of my studies at the University of Oslo I would like to thank my fellow students for making this time an enjoyable experience.

Any remaining errors and the interpretations in this thesis are entirely my responsibility.

Oslo, May 2010

Mads Berg.

Table of contents

1	Introduction	1
2	Monetary policy.....	3
2.1	Determinants of monetary policy	3
2.1.1	Inflation-targeting frameworks.....	4
2.2	The transmission mechanism	5
3	A model of strict inflation-targeting.....	8
3.1	The model.....	8
3.2	The data	10
3.2.1	The variables of the baseline economy	10
3.2.2	The inflation target	11
3.2.3	Expected inflation.....	11
3.2.4	Constructing expected inflation.....	13
3.2.5	Policy impact coefficients	15
4	A model of flexible inflation-targeting.....	19
4.1	The Taylor rule	19
4.2	The Taylor-rule model.....	21
4.2.1	Estimating the output gap.....	22
4.2.2	The Taylor-rule with expectations data.....	25
5	Results	26
5.1	Output stabilization	26
5.2	The Taylor-rule and actual policy	28
5.2.1	Monetary policy in the Euro area	33
5.3	Interpretation of the results.....	34
5.3.1	Possible extension of the models.....	36
6	Conclusion.....	37
	Bibliography	39
	Appendix A: Figures	41
	Appendix B: Data	60

List of Figures

Figure 1: The trade-off between inflation variability and output gap variability	4
Figure 2: Sweden policy interest rate and output gap results	27
Figure 3: Canada policy interest rate and output gap results	30
Figure 4: USA policy interest rate and output gap results	32
Figure 5: Germany policy interest rate and output gap results	34
Figure series 1: Policy interest rates and output gaps	41
Figure Series 2: Expected and actual Inflation	54
Figure series 3: Unemployment data	58

List of tables

Table 1: Effect of a policy interest rate increase in the euro area.	15
Table 2: Effect of a policy interest rate increase in the euro area and the United States	17
Table 3: Output gap estimation results	24

1 Introduction

The importance of monetary policy is unchallenged in modern macroeconomics and its prominent place in the theoretical discourse is unchallenged. Economists have offered several attempts to define the determinants of monetary policy in order to offer an optimal solution to a complex problem. Some well known examples of this in the literature are the Friedman rule, the Taylor rule and most recently central bank independence and inflation targeting (Bernanke and Mishkin, 1997). The main target in the recent decades for monetary policy has been to achieve low and stable prices by stabilizing inflation. However, research has shown that a strict adherence to this policy can potentially have a destabilizing effect on the economy. In addition to the goal of price stability, an increasing number of central banks are clear in announcing their attempt to stabilize output. These tandem goals of monetary policy are often referred to as flexible inflation targeting. According to Svensson (2002) there is a general agreement that this is how central banks in industrialized countries conduct their policy.

With the main goals of stabilizing inflation and the output in mind, this thesis aims to investigate how these goals determine monetary policy. How much emphasis does a central bank put on each of these goals, and has the relative importance of them changed over time? Furthermore, if a central bank put more emphasis on the main goal of stabilizing inflation, would this lead to more volatility of the output?

To address these questions, the thesis will compare the actual policy interest rate with the outcome of two simple policy rules for 13 OECD member countries between 1990 and 2005. The first policy rule is based on a strict inflation-targeting approach. Here the central bank only attempts to reach the inflation target in the short-term, so the interest rate is set according to this. The second policy rule is based on the well-known Taylor rule (Taylor, 1993). This rule suggests that the central bank puts some weight on both inflation variability and output gap variability, making it a flexible inflation-targeting policy rule (Svensson, 2002). The policy interest rates and the output-gaps of the policy-rules will then be compared to the outcome of the actual policy represented in graphs. The outcome of the strict-inflation targeting rule is calculated for all 13 countries, but due to restrictions in the data set the Taylor policy-rule is only calculated for 7 of these countries.

The approach outlined for this paper poses some challenges in how to construct the policy rules. For the policy rules to be effectively compared to the actual policy, they will have to be based on information that was available at the time when the central banks made their policy decisions. Knowing the exact information set of the central bank is out of the scope of this paper. In order to solve this problem, real-time data obtained from Consensus Economics Inc. (2010b) is used as forecast of the expected inflation with unchanged policy. The advantage with the data from Consensus Economics Inc. is that it is real-time and thus not revised ex post. These forecasts should be good proxies for the central bank forecasts, even if they are not likely to be identical.

The analysis implicates that monetary policy in the period between 1990 and 2005 appears to be best explained as following a flexible inflation-targeting approach. Comparing the actual policy with the two policy-rules shows that the Taylor-rule interest rate follows the actual interest relatively closely for the countries in the sample. The strict inflation-targeting rule is rather different from the actual monetary policy apart from when expected inflation is close to target. However, as the strict inflation-targeting rule exclusively focuses on controlling inflation the effect is an increase in output gap variability. Furthermore, the relative weight on the targets of the monetary policy appears to have shifted somewhat during the sample period, allowing for an increased focus on output stabilization.

This thesis is divided into six sections and is as follows. Section 2 aims to summarize and comment on the policy of inflation targeting which will serve as the departure point for the analysis of this paper. Section 3 introduces the model of strict inflation-targeting policy rule, while section 4 introduces a flexible inflation-targeting rule in the form of a Taylor-rule. Section 5 presents the results of these simple policy rules and attempts to address the research questions by comparing these to the actual policy rates. Section 6 summarizes the results and concludes.

The econometric estimations were conducted in PcGive, and all other calculations and graphs were compiled in Microsoft Excel.

2 Monetary policy

2.1 Determinants of monetary policy

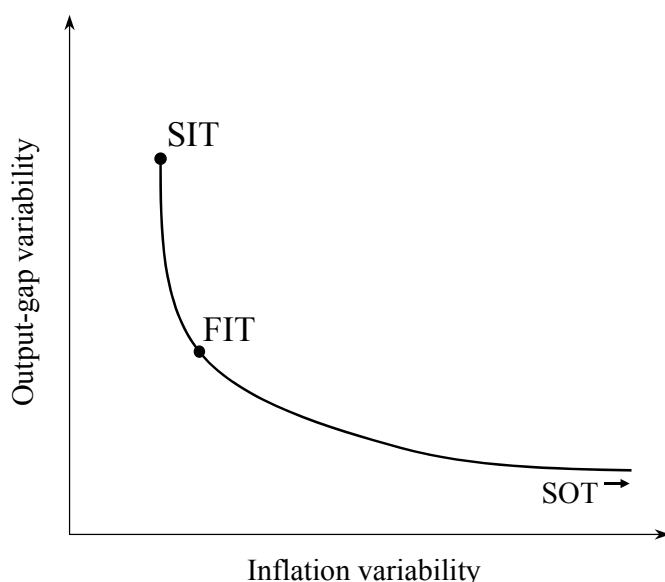
The main task that central banks have been faced with in recent decades is to ensure low and stable inflation (Svensson, 2002). This task is achieved by utilizing its policy tools, such as the policy interest rate, to impact inflation through the transmission mechanism. The nature of the transmission mechanism and how the policy interest rate affects the real and nominal values of the economy is an important issue in designing monetary policy (Svensson, 2002). As the discussion in section 2.2 on the transmission mechanism will demonstrate, monetary policy affects inflation and the output in a number of ways. A more important aspect of this is how the impact on inflation and the output are different, and how this contributes to a trade-off in the conduct of monetary policy. However, the difference is not the only source for the trade-off. Unpredictable shocks will constantly affect the economy, so that the central banks control over inflation and output will be imperfect (Svensson, 2002).

Although monetary policy can achieve a long-run target of a low average inflation, it is unrealistic to expect that it can achieve a long-run growth target for the economy (Svensson, 2002). Economic growth in the long run, such as the potential output growth, is decided by other factors, which are outside the influence-sphere of monetary policy. Sound monetary policy should instead attempt to provide a stable environment for the real economy. Due to the destabilizing nature of high and volatile inflation, monetary policy should introduce a nominal anchor for inflation expectations (Svensson, 2002). The nominal anchor creates a guide for the economic actors to follow, as they will know that the average inflation will have to equal the central bank's official inflation target (Birch Sørensen and Whitta-Jacobsen, 2005). If average inflation deviates from the target because of unexpected shocks to the economy, economic agents will anticipate that it will return to target again in the long term. By credibly anchoring inflation expectations, monetary policy can avoid increasing inflation and ensure a stable macroeconomic environment. Several countries have chosen to anchor inflation expectations at a level between, or band around 2-2.5 percent, which also seems to be the consensus among inflation-targeting countries (Birch Sørensen and Whitta-Jacobsen, 2005).

2.1.1 Inflation-targeting frameworks

With the nominal anchor for inflation set at a level which is considered to be consistent with the goal of price stability, the central bank is believed to be conducting an inflation-targeting policy. In theory, it is usual to separate between two different types of inflation targeting, strict and flexible (Birch Sørensen and Whitta-Jacobsen, 2005). A strict inflation targeting policy aims solely on fulfilling the inflation targeting, while the flexible version also takes into consideration the output gap and other macroeconomic variables. There are recognized trade-offs in the choice of inflation-targeting framework, mainly through the concepts of inflation variability and output gap variability.

Figure 1: The trade-off between inflation variability and output gap variability



Source: Figure 2.1 in Svensson (2002).

The axes in figure 1 measures output variability on the vertical axis and inflation variability on the horizontal axis. The intersection point illustrates the unfeasible situation where both output gap variability and inflation variability equals 0 (Svensson, 2002). The curve, labeled the Taylor-curve, shows the most efficient and feasible combinations of inflation and output gap variability that can be achieved by monetary policy. The curve implies that points to the right and above are feasible, but inefficient as moving towards the curve can reduce both

inflation and output gap variability. And points to the left are unobtainable for monetary policy (Svensson, 2002).

The SIT-point on the Taylor-curve represents strict inflation-targeting, and inspecting the intersection of this point on the axes show that this policy has the lowest possible inflation variability, but a high degree of output gap variability. The FIT-point represents flexible inflation-targeting where the central bank has put some weight on stabilizing the output gap along with stabilizing inflation (Svensson, 2002). It can be traced from the Taylor-curve that flexible inflation-targeting framework drastically decreases the output gap variability by allowing inflation to vary only somewhat more than under strict inflation-targeting (Svensson, 2002). The SOT point referring to strict output gap targeting is a situation where the central bank puts all weight on stabilizing the output gap. Removing any consideration for inflation also removes the nominal anchor of monetary policy, and is therefore not relevant when discussing inflation targeting (Svensson, 2002).

Of the feasible outcomes illustrated by the Taylor-curve, considerable agreement has been reached between policymakers, experts and researchers that the flexible inflation-targeting approach constitutes the best compromise for monetary policy (Svensson, 2002). It is recognized that monetary policy can never perfectly control both inflation variability and output gap variability. However, there is a general agreement that inflation-targeting central banks in industrialized countries tend to adhere to conducting flexible inflation targeting (Svensson, 2002; Birch Sørensen and Whitta-Jacobsen, 2005).

2.2 The transmission mechanism

The models in the latter sections reduce the transmission mechanism to two single impact coefficients, and thus ignore the true underlying complexity that characterizes this mechanism. This section will briefly discuss the transmission mechanism of monetary policy, and it aims to give an overview of the various ways that the policy interest rate influences the target values to reach the goals associated with flexible inflation-targeting.

As an example, consider the primary policy objective of the European Central Bank (ECB). The objective is to ensure price-stability by keeping the inflation rate below a target of 2 percent over the medium-term (ECB, 2010). In addition to keeping the inflation rate below 2 percent, the ECB also aims at avoiding unnecessary fluctuations of other macroeconomic

variables such as the Gross Domestic Product (GDP). In order for the ECB to attain these goals through the policy interest rate, its policymakers will need to understand the interest rate affects these variables (ECB, 2002).

The effects of monetary policy on the real and nominal values of the economy are transmitted through what is often referred to as the “transmission mechanism” of monetary policy (Svensson, 2002). The term “transmission mechanism” refers to a number of channels in which the effects of the policy interest rate operates through. The channels are usually identified as, (1) The direct exchange rate channel to CPI inflation, (2) the real-interest-rate channel to aggregate demand, (3) the exchange rate channel to aggregate demand, (4) the aggregate-demand channel to domestic inflation and (5) the expectations channel to domestic inflation (Svensson, 2002).

To illustrate these channels and how they impact the economy, the following example on the Norwegian economy is from Brubakk and Sveen (2009). In a small open economy such as Norway, consider the following effects of an increase in the policy interest rate. With sticky prices and wages present in the economy, this increase leads to an increase in the real interest rate. Furthermore, for a small economy, it seems reasonable to assume that the foreign real interest rates remain at the same level as before. The rise in the domestic real interest rate will then increase the interest rate differential. This in turn results in a real appreciation of the domestic currency. The appreciation makes imports cheaper in terms of the domestic currency, leading to a decrease in inflation through channel (1). How swift and with what magnitude this channel impacts inflation depends on how import-prices are adjusted due to the change in the exchange rate. According to Svensson (2002) this usually occurs with a year from the monetary policy shock.

Furthermore, the increase in the real interest rate lowers demand for consumption and investment and the appreciation of the domestic currency lowers demand for domestically produces goods and services, as the price for foreign goods and services falls. The combined effects results in a decrease in the aggregate demand, and refers to channel (2) and (3). The lower aggregate demand in the economy also decreases the inflationary pressure through channel (4). The role of expectations and the importance this has on future developments in macroeconomic variables such as inflation is captured in channel (5). As discussed above in regards to the nominal anchor, expectations play an important part of the transmission mechanism. If the central bank operates with a credible nominal anchor for inflation, this

should inform economic agents that average inflation in the long term would equal the nominal target (Svensson, 2002). If the inflation expectations of the economic agents are close or equal to the nominal anchor set by the central bank, research has concluded that actual inflation shows a strong tendency to revert to target if brought away (Svensson, 2002).

3 A model of strict inflation-targeting

The model presented in this section takes the form of a policy rule of setting the policy interest rate with a strict goal of closing the inflation gap¹. To close the inflation gap the policy aims at making inflation equal the chosen inflation target over the chosen policy horizon. Thus the policy rule is in line with the strict inflation-targeting approach discussed earlier. Under a strict inflation targeting policy the central bank concentrates its policy measures on stabilizing inflation without consideration for the output gap variability (Svensson, 2002). The motivation for choosing to base a model on this policy rule is to trace the effects that such a policy has on the stability of the economy represented by the output-gap. But also to investigate if this rule can explain the actual policy followed by the countries in the analysis.

3.1 The model

The main component of the model is to derive a policy interest rate for country j , $i_{j,t}^K$, that will have an impact on inflation in period $t+4$, so that it will equal the inflation target, Π^* . The policy interest rate is set in each quarter in this model, so that the subscript t indicates quarterly values. For simplicity it is further assumed that the interest rate set in period t only affects inflation in period $t+4$. By making this restriction on the effect of the interest rate, the model departs from evidence of the transmission mechanism. However, this restriction is done in the interest of keeping the model simple.

The deviation of the expected inflation from target is

$$(3.1) \quad \Delta E_{j,t}(\Pi_{j,t+4}) = E_{j,t}(\Pi_{j,t+4}) - \Pi^*,$$

where $E_{j,t}(\Pi_{j,t+4})$ is the expectation in period t of the inflation rate in period $t+4$.

The monetary policymaker sets the interest rate to ensure that expected inflation is on target, i.e. that $\Delta E_{j,t}(\Pi_{j,t+4}) = 0$. The level of the policy interest rate that can accomplish this ($i_{j,t}^K$) must differ from the actual policy rate ($i_{j,t}$) by $\Delta i_{j,t}$, as shown in equation 3.2.

¹ The model is based on a draft by Steinar Holden.

$$(3.2) \quad i_{j,t}^K = \Delta i_{j,t} + i_{j,t}$$

The change in the interest rate ($\Delta i_{j,t}$) must be sufficient enough to eliminate the expected deviation in equation 3.1. In order to find the necessary change in the policy interest rate to do this, one needs the coefficient that represents the impact of the policy interest rate on inflation. This coefficient will be called A, and its value in regards to the model will be discussed in a later paragraph. This requires that $\Delta i_{j,t}$, must be set to eliminate the expected deviation in equation 3.1, that is

$$(3.3) \quad \Delta E_{j,t}(\Pi_{j,t+4}) = A \Delta i_{j,t}$$

If we now insert equation 3.2 into 3.3 and then rearrange, we find that the policy interest rate ($i_{j,t}^K$) that eliminates the expected deviation of inflation from target is given by equation 3.4.

$$(3.4) \quad i_{j,t}^K = \frac{\Delta E(\Pi_{j,t+4})}{A} + i_{j,t}$$

Equation 3.4 shows the level of the policy interest rate that ensures that the expected inflation is equal to target in period t+4.

As the interest rates derived from this model are of nominal values they are restricted by the rule of a zero lower bound on the nominal interest rate. This rule prescribes that the central bank is unable to set a nominal interest rate below zero, as no one would obtain financial assets that carry a negative nominal return (Romer, 2006). In cases where the nominal interest rate is sufficiently low and the central bank is faced with inflation expectations sufficiently below the inflation target, this rule becomes relevant for the model. In these cases the interest rate differential ($\Delta i_{j,t}$) is negative to a magnitude that creates a nominal interest rate ($i_{j,t}^K$) with a value below 0. As this is not a valid nominal interest rate according the zero lower bound rule, the model has been calibrated so that a negative $i_{j,t}^K$ is automatically set to a value of 0,25 percentage points.

In order to investigate the trade-off between inflation variability and output gap variability, the next step will be to find the effect of the change in the policy interest rate on the output gap. As the assumption is that the policy interest rate affects the economy with a 1-year lag, the effect on the real GDP occurs in period t+4. This effect, represented by coefficient B,

measures the impact of a percentage-point change in the policy interest rate on the real GDP in period $t+4$. So if $Y_{j,t+4}$ represent the actual real GDP for country j in period $t+4$, the change in the real GDP due to the change in the policy interest rate in period t , $\Delta i_{j,t}$, is given by

$$(3.5) \quad \Delta Y_{j,t+4} = B \Delta i_{j,t}.$$

The next step is to investigate the effect on the output gap of the change in the policy interest rate. Let the actual output gap for country j in period $t+4$ be the $y_{j,t+4}$, which is the percentage deviation of the actual real GDP ($Y_{j,t+4}$) and the potential real GDP of the economy ($\hat{Y}_{j,t+4}$).

$$(3.6) \quad y_{j,t+4} = ((Y_{j,t+4} - \hat{Y}_{j,t+4}) / \hat{Y}_{j,t+4}) * 100$$

Given the change in the policy interest rate from equation 3.5, the output in period $t+4$ would be,

$$(3.7) \quad Y_{j,t+4}^* = Y_{j,t+4} * (1 - (\Delta Y_{j,t+4} / 100)).$$

As potential output of the economy is not affected by the interest rate, the resulting output gap is found by replacing $Y_{j,t+4}$ with $Y_{j,t+4}^*$ in equation 3.6, yielding equation 3.8.

$$(3.8) \quad y_{j,t+4}^* = ((Y_{j,t+4}^* - \hat{Y}_{j,t+4}) / \hat{Y}_{j,t+4}) * 100$$

3.2 The data

The next step is to make the analysis operational by defining the necessary variables and parameters. These are the expected inflation ($E_{j,t}(\Pi_{j,t+4})$), the policy impact coefficients A and B , the inflation target (Π^*) and the variables of the baseline economy, the actual policy interest rate ($i_{j,t}$), the real GDP ($Y_{j,t+4}$) and the potential real GDP ($\hat{Y}_{j,t+4}$).

3.2.1 The variables of the baseline economy

The model uses ex post economic variables from the countries included in the analysis to form a baseline economy from which the outcome of the model is compared to. The variables included in the baseline economy of country j are the realized policy interest rate ($i_{j,t}$), the

real GDP ($Y_{j,t+4}$) and the potential real GDP ($\hat{Y}_{j,t+4}$). The values for these country-specific variables are obtained from the OECD economic outlook database, Economic Outlook: Annual and quarterly data Vol. 2009 release 03 (OECD, 2009a). This database is a comprehensive and consistent database of economic variables, which covers a wide range of macroeconomic variables, both historical and projections for future periods (OECD, 2009b). The time period that is of concern in this analysis is from the 1st quarter of 1990 to the 4th quarter of 2005. All values for the baseline economy variables have been obtained from the OECD economic outlook database².

3.2.2 The inflation target

An important part of an inflation-targeting policy, whether it is strict or flexible, is the inflation target. The inflation target plays an important role in this model as it defines the desired level of inflation, which the central bank aims to realize when setting the interest rate. The inflation target in the model is set to a level of 2 percent. This level is consistent with the levels chosen by countries that are referred to as ‘best-practice’ countries of inflation targeting policy³. Recently other countries in Eastern Europe and other developing countries that currently are reducing inflation are aiming at the level of these ‘best practice’ countries (Birch Sørensen and Whitta-Jacobsen, 2005).

Not all central banks publish an explicit inflation target level such as the target level chosen in this model. Some central banks operate with a tolerance band which inflation is targeted to be within. The tolerance bands are usually in the range between 1-3 percent, so that a mean point would be in the 2-2.5 percent range (Birch Sørensen and Whitta-Jacobsen, 2005). Thus an inflation target of 2 percent in the model seems as a reasonable parameter value.

3.2.3 Expected inflation

Since monetary policy in general only has an effect on economic variables with different lags, policymakers need to be forward looking when making policy decisions. This means that policymakers will have to utilize forecasts of the target variables as intermediate target

² The variables included are listed in appendix B.

³ These countries include Australia, Canada, Israel, New Zealand, Norway, Sweden and the United Kingdom (Birch Sørensen and Whitta-Jacobsen, 2005).

variables in decisions models utilized in policy decisions. This is also called ‘forecast targeting’, and is crucial element to practical monetary policy (Svensson, 2002).

In the empirical model, where expected deviation of inflation from its target is the only target variable, it is necessary to forecast the expected inflation. For the 13 countries included in the empirical analysis, real-time forecasts are obtained from Consensus Economic Inc. (2010b) and cover the time period between 1990 and 2005. Consensus Economics Inc. publishes monthly forecasts of several economic indicators covering over 80 nations in industrialized countries, Asia Pacific, Eastern Europe and Latin America (Consensus Economics Inc., 2010a). According to Consensus Economics Inc. (2010a) the forecasts are compiled by a number of the leading forecasting institutions in the world. Each month for a given country included in the forecast, a number of local and international forecasters predict the expected values for a number of economic indicators. For the countries included in this paper the number of forecasters per country is in the range of 10-30. These individual predictions are then pooled and a mean is computed, which in turn becomes the consensus forecast for the given macroeconomic variable (Ager et al. 2009). Due to this aggregation of the individual predictions, the consensus forecast is often seen as the opinion in the market about future economic developments (Ager et al. 2009).

By using the forecasts provided by Consensus Economics Inc. as a proxy for the inflation forecast that a central bank bases its policy decisions on, creates some issues that should be noted. Firstly, it is realistic to believe that a central bank considers a broad range of information that it deems relevant when it forms its projections of the target variables (Clarida et al. 1998). Take the Norwegian central bank (Norges Bank) as an example. Norges Bank uses a variety of models, especially short-term models, to forecast the future developments in the Norwegian economy (Brubakk and Sveen, 2009). Due to the range of models and information sets that are used by central banks, this will yield different projection paths of the target variables. From these, the central bank must choose the projection that it deems suitable to base policy decisions on (Svensson, 2002). One strength of the forecasts by Consensus Economics Inc., is that they are made by professional forecasters from leading financial institutions (Blix et al. 2001). Professional forecasters analyze large quantities of information to derive their predictions, and by pooling a number of these forecasters one would hope that a considerable amount of the available relevant information is represented in the forecast means. Because of this there is no reason to believe that professional forecasters will utilize

relevant information in a less efficient manner than the central bank, or that the internal forecasts made by the central bank is superior.

A second point of contention that should be noted is the accuracy of the forecasts. Since monetary policy is critically dependent on forecasts, poor forecasts could potentially lead to policy failures (Blix et al. 2001). Blix et al. (2001) concluded a survey on the consensus forecast to identify possible forecast errors. The survey found that when comparing the forecasts of inflation and GDP, there seemed to be higher errors in forecasting GDP than inflation across the countries. These differences in forecast errors are attributed to the relatively higher complexity in estimating GDP and the success for several of the economies to achieve price stabilization during parts of the survey period (Blix et al. 2001). Further the survey found evidence of upward biased forecasts of inflation in several of the countries. The survey also found evidence of problems forecasting turning points in the cyclical growth of the economy (Blix et al. 2001). These forecast errors outline the worst-case scenario presented by Blix et al. (2001) and how they can have grave impacts on the conduct of policy. If the forecasts are systematically wrong about the underlying economic trend that determines inflation, and policy is conducted based on these forecasts we would expect an adverse effect on the economy. However, the problematic issues faced by professional forecasters when making predictions are general to the art of forecasting. The internal forecasts of central banks are not exempt from these issues, and thus not from making forecasting errors (Blix et al. 2001).

Due to these problems, forecasts are not expected to be a true blueprint of the future path of the economy. As a result one would expect that the forecasts would differ from the actual values. Blix et al. (2001) conclude that for most countries, the consensus forecasts that were included in their survey, the mean provided a stable and reliable forecast. The predictions delivered by the individual forecasters are based on relevant available information at the time and are real-time; hence they are not revised ex post. This makes the consensus forecast a good proxy for the forecast of the policymaker in the empirical models.

3.2.4 Constructing expected inflation

The data from consensus forecasting is published for each month so the data set will have to be modified to fit the empirical model. As the variables from the baseline economy obtained from the OECD database are based on quarterly data, the data from the consensus forecast

must be modified accordingly⁴. Data for the 4 quarters each year are constructed from the consensus forecast for February, May, August and November. Each month includes predicted values for the average percentage change in consumer prices for the current year (t) on the previous calendar year, and for the average percentage change in consumer prices for the following year (t+1) on the current year. As a simplification to compute the expected inflation, the average percentage change in the consumer prices for year t is interpreted to apply from July 1st the preceding year t-1 to July 1st year t. Similarly, the average percentage change for the following year (t+1) is interpreted to apply from July 1st in year t to July 1st year t+1. Lastly, expected inflation is assumed to be constant throughout the year. With these assumptions quarterly observations for expected inflation can be constructed as follows.

For the month of February year t, expected inflation for year t+1 ($E_{j,t}(\Pi_{j,t+4})$), is assumed to be the average percentage change in consumer prices from February 15th year t to February 15th the following year (t+4).

$$(3.9) E_{j,t}(\Pi_{t+4}) = E_{j,t}^{CF}(\Pi_t) * (4,5/12) + E_{j,t}^{CF}(\Pi_{t+4}) * (7,5/12)$$

The predicted average change in consumer prices for the year t ($E_{j,t}^{CF}(\Pi_t)$) applies to the period from the February 15th to July 1st, hence the weight (4,5/12). The predicted average change for the next year applies to the period from July 1st year t to February 15th year t+1, hence the weight (7,5/12). For the second quarter, the average percentage change in consumer prices from May 15th year t to May 15th the following year (t+1) is computed as follows.

$$(3.10) E_{j,t}(\Pi_{t+4}) = E_{j,t}^{CF}(\Pi_t) * (1,5/12) + E_{j,t}^{CF}(\Pi_{t+4}) * (10,5/12)$$

Due to persistence in economic variables between periods such as for the inflation rate (Birch Sørensen and Whitta-Jacobsen, 2005), using a weighted method appears to be a reasonable choice.

Unfortunately, the data set only includes predicted values for year t and the following year (t+1), but not for year t+2. This means that for the construction of the expected average percentage change in consumer prices in the 3rd and 4th quarter, cannot follow the same method as above. As a simplification these values are assumed to be the inflation forecast for year t+1 for August and November in year t.

⁴ Based on notes from Steinar Holden.

$$(3.11) E_{j,t}(\Pi_{t+1}) = E_{j,t}^{CF}(\Pi_{t+4})$$

The constructed values of the average percentage change in consumer prices and the actual ex post values obtained from the OECD database are illustrated in graphs in the appendix A.

The calculation of the expected inflation is based on the assumption that the forecasts are conditioned on an unchanged policy rate. Information on this was not included in the data set (Consensus Economics Inc. 2010b), but based on the article by Blix et al. (2001) there is reason to conclude that this is not the case. The forecasts are presumably made on the assumption of a changed policy interest rate. Due to this, a possible extension of the model would be to include the expected future interest rate when calculating the policy interest rate, but this is not included in the current analysis.

3.2.5 Policy impact coefficients

The coefficients for the impact of the policy interest rate on inflation and the on real GDP play a central role in the empirical models in this paper. Researchers at institutions such as central banks and universities routinely attempt to estimate these policy impact coefficients, using a variety of different models and data. Table 1 summarizes the results from three different macroeconomic models that have been used to quantify these estimates. The results are obtained for the euro area as a whole (ECB, 2002).

Table 1: Effect of a policy interest rate increase in the euro area.

Response to a 1% increase in the policy interest rates of the euro area						
	Real GDP			Consumer Prices		
	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3
AWM	-0,34	-0,71	-0,71	-0,15	-0,30	-0,38
NCB	-0,22	-0,38	-0,31	-0,09	-0,21	-0,31
NiGEM	-0,34	-0,47	-0,37	-0,06	-0,10	-0,19
Source: ECB (2002).						

The three models that are used to obtain these estimates are the ECB's area-wide model (AWM), the aggregations of simulations of the individual national central bank country models (NCB) and the NiGEM multi-country model developed by the National Institute of Economic and Social Research (NIESR) in the United Kingdom (ECB, 2002). The basis for

the estimates is a simulation of a temporary increase of 100 basis points in the policy interest rate, which lasts for 2 years. The increase is assumed to be unexpected, which is in line with academic literature, but the article also acknowledges the fact that policy moves are to a certain degree anticipated by economic agents. For the results this means that the simulation is lumping together all effects of the policy change, also any reaction to early signals and other preceding information (ECB, 2002). As one can see from table 1, the impact on the real GDP is of a higher magnitude than the impact on consumer prices. The estimates also reach their peak value at an earlier time than those of consumer prices. The simulations also confirmed that the effect on inflation is permanent, while the effect on the real GDP is found to be temporary. These results are said to be both qualitative and quantitative comparable to empirical literature on the effects of monetary policy in other countries (ECB, 2002). The second point relating to the temporary effect on the real GDP is referred to as “short run non-neutrality”. Empirical evidence suggest that the effect of the policy interest rate on the real GDP is not significant in the long-term, but have significant effects in the short-term. This is explained to be a result of the nominal and real rigidities in the goods and labor markets that prevents prices to adjust swiftly in reaction to changes in monetary policy (ECB, 2002). This short run non-neutrality of the real GDP has important implications for monetary policy in terms of output stabilization.

The estimated values presented in table 1 are according to the ECB (2002) robust across different methodologies and in line with economic theory. It should be noted the ECB (2002) also warns against the degree of uncertainty that is associated with the estimates. The direction of the estimated variables are backed by a general consensus in economic theory, but the estimated impacts will be different across countries as they depend on the structure of the economy and the monetary policy regime.

Impulse responses to an unexpected shock to monetary policy, by an increase in the policy interest rate, in the “Norwegian Economy Model” (NEMO) used by Norges Bank show effects of different magnitude and timing than the ECB simulations (Brubakk and Sveen, 2009). The NiGEM model referred to in table 1 included the possibility to decompose the transmission channel by country so that the aggregated results could be traced to the individual contributors (McAdam and Morgan, 2001). The individual results show that the magnitude and timing of the impact are different among the Euro area countries. The results also showed that the initial impact for the countries that relied most on trade with countries

outside of the EU was above average when the euro exchange rate had a marked appreciation (McAdam and Morgan, 2001). Similar research on the transmission mechanism in the United States confirms the cross-country differences in the timing and magnitude of the responses. Angeloni et al. (2003) compare the results from the NBC and AWM simulations with a similar simulation for the U.S. The results for the impact on the real GDP and consumer prices are presented in table 2 for comparison.

Table 2: Effect of a policy interest rate increase in the euro area and the United States

Response to a 1% increase in the policy interest rates in the euro area and the United States						
	Real GDP			Consumer Prices		
	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3
AWM	-0,27	-0,71	-0,79	-0,13	-0,26	-0,37
NCB	-0,22	-0,38	-0,31	-0,09	-0,21	-0,31
FRB/U.S.	-0,35	-1,28	-1,37	-0,07	-0,41	-1,01
Source: Angeloni et al. (2003)						
Note: The results from the AWM simulations are different from the values in table 1. Different sources are cited in the two papers						

The difference in the estimates of the impact on the real GDP is apparent in table 2. The policy interest rate in the U.S. has a stronger impact on inflation and the real GDP than in the euro area. Angeloni et al. (2003) give a possible explanation of this based on disposable income being less responsive to monetary changes in the euro area than in the U.S. Finding a compelling explanation for this was outside the scope of the article, but it is speculated that this might be due to social safety nets in Europe that might cushion the policy effects (Angeloni et al. 2003).

The chosen results presented above show that the transmission mechanism differs across countries depending on the structure of the economy and monetary policy regimes. When deciding on the appropriate values of the impact coefficients A and B, on inflation and the real GDP, this cross-country difference will have implications. In interest to keep the model simple and straightforward, the coefficient values are assumed to be the same for all countries and constant throughout the sample period. The effect of this is that for the countries analyzed the coefficient values might be an over or understatement of the true values. Further, as the policy horizon of the model is limited to 1 year, the coefficients will also have to reflect this.

The values of the coefficients A and B will be based on the estimates in table 1 of the euro area aggregates. The coefficient for the impact of the policy interest rate on inflation, A, takes the value 0,3 in the model. From table 1 the average accumulated value of the impact on inflation is approximately 0,6 percentage points for the 3 models. However this result was based on a percentage point increase in the policy interest rate lasting for 2 years. As a rough approximation the effect of a percentage point increase lasting for one year is then half of this value, which yields a value for A of 0,3 percentage points. This means that in the model, a percentage point increase in the policy interest rate in period t is assumed to lower inflation by 0,3 percentage points in period t+4. The estimation of the impact coefficient on the GDP is conducted by the same method. The average accumulated value of the impact on the GDP is 1,2 percentage points. Thus a percentage point increase in the policy interest rate in period t is assumed to lower the real GDP by 0,6 percentage points in period t+4. These coefficient values are rough approximations, and due to the simplification of the model, depart from reality and the complexity of the transmission mechanism. Their validity can thus be challenged, however they still retain a good explanatory power in the model.

4 A model of flexible inflation-targeting

As the first empirical model examines the predicted appropriate policy response of a central bank in a strict inflation-targeting scenario, the next section will investigate how the policy response would be if the central bank instead followed a policy rule of flexible inflation-targeting. Under a flexible inflation-targeting system, a policy rule must put some weight on stabilizing the output-gap variability in addition to stabilizing the inflation variability according to the specified inflation target (Svensson, 2002).

4.1 The Taylor rule

The flexible inflation-targeting policy rule utilized in this section will take the form of the standard simple interest rate rule proposed by Taylor (1993). The rule takes the technical form as presented in Ahrend (2008) and is illustrated in equation (4.1).

$$(4.1) \quad i_t^T = \Pi_t + r^* + \lambda_1(\Pi_t - \Pi^*) + \lambda_2(y_t)$$

i_t^T is the nominal policy rate according to the Taylor-rule, Π_t is the rate of inflation, Π^* is the desired inflation target, r^* is the neutral real interest rate, y_t is the output gap and λ_1 , λ_2 are the relative weights put on stabilizing inflation and output gap respectively. The Taylor-rule has two important normative elements in regards to interest rate decisions (Romer, 2006). The first element is that the nominal policy rate will have to rise by more than one-to-one with inflation, so that in turn the real interest rate also rises. The second element is that the nominal policy rate will have to react to deviations of the output from the natural rate of output of the economy. By specifying y_t as the percentage deviation from the potential output, the nominal interest rate will increase if y_t is above potential and ceteris paribus, decrease if y_t is below potential output (Romer, 2006).

Taylor showed that this interest rate rule gave a good description of the U.S. monetary policy during the time period 1987-1992, by setting both λ_1 and λ_2 to 0,5 and r^* and Π^* to 2 percent (Taylor, 1993). Rearranging equation (4.1) and inserting the values for λ_1 and λ_2 gives the following equation.

$$(4.2) \quad i_t^T = \alpha + \beta \Pi_t + 0,5(y_t)$$

Where $\alpha = r^* - 0,5\Pi^*$ and $\beta = 1 + 0,5$. This shows that inflation is reacted to in more than a one-to-one manner and that the output-gap property is maintained. Similar results were found by Gerlach and Schnabel (2000) when they investigated whether the ECB conducted monetary policy according to a Taylor rule during the time period 1990-1997. Their estimations yielded coefficient values close to the ones proposed by Taylor, and the article concluded that if the ECB had followed a Taylor-rule during this period, interest rate setting would not deviate much from the actual outcomes (Gerlach and Schnabel, 2000).

With the relative success of the simple specification of the original interest rule created by Taylor, a desire to further explain the conduct of monetary policy has led to augmentations of the original rule (Romer, 2006). Adding additional variables like the exchange rate and the lagged value of the interest rate might add desirable abilities to the rule. By augmenting the effect of the interest rate with the output-dampening effect of an appreciation of the domestic currency, could yield lower interest rates to achieve the same target as a rule without an exchange rate variable. Adding the effect of the lagged interest rate implies to the economic agents that the interest rate will remain at a certain level for a longer period, but also lead to less interest rate volatility (Romer, 2006).

As to be expected with normative rules there has been a great deal of discussion surrounding possible problems with constructing interest rules with desirable outcomes (Romer, 2006). The variables which are included in the rule are variables that are measured with a high degree of uncertainty and these estimated values will always be open to be challenged (Romer, 2006; Ahrend, 2008).

Despite the issues concerning the use of simple interest rate rules, such as the Taylor rule, they are still very much utilized when attempting to decompose actual policy or as benchmark when evaluating actual policy inflation targeting regimes ⁵.

⁵ Examples of this can be found in Gorter et al. (2008), Gerlach & Schnabel (2000), Ahrend (2008).

4.2 The Taylor-rule model

The departure point for the model in this section is the Taylor-rule presented in equation 4.1. The primary goal is to investigate how policy interest rates would be affected that by using real-time expectations data from Consensus Economics Inc. (2010b) with the Taylor-rule. The Taylor-rule in equation 4.3 has transformed equation 4.1 into a forward-looking rule based on expected future values of the policy variables. As with the strict inflation-targeting model earlier, the data set limits the policy horizon of the model to the next 4 quarters a head, so the forecasts entering the model will be forecasts made in the current quarter (t) on variables 4 quarters ahead (t+4).

$$(4.3) \quad i_{j,t}^T = E_{j,t}(\Pi_{t+4}) + r^* + \lambda_1(E_{j,t}(\Pi_{t+4}) - \Pi^*) + \lambda_2(E_{j,t}(y_{j,t+4}))$$

Where $E_{j,t}(y_{j,t+4})$ is the expected output gap in period t for period t+4, and the other parameters and variables is as in equation 4.1. Like much of the literature (e.g. Ahrend, 2008) the model will use the coefficient values suggested by Taylor (1993) for and the weighs on stabilizing inflation and output. So $\lambda_1 = \lambda_2 = 0,5$.

The value for the assumed neutral real interest rate (r^*) is more difficult to establish, and the concept in itself is surrounded by a degree of uncertainty. The following definition for the neutral real interest rate is proposed by (Bernhardsen and Gerdrup, 2007), and states that it is the level of the real interest rate that is consistent with a closed output gap in the medium-term. With respect to the degree of uncertainty surrounding the neutral real interest rate, Blinder has stated that it is a number which is difficult to estimate and impossible to know with precision (Bernhardsen and Gerdrup, 2007). However, the Taylor-rule requires an estimated value of the neutral real interest rate in order to yield results. Estimation of the neutral real interest rate varies with the estimation method and the sample countries. An overview of recent estimations are offered in Bernhardsen and Gerdrup (2007), and although the different estimates vary between the surveys they seem to converge on an estimate between 2-4 percent in the 1990s and early 2000 in both the Euro area and the United States. Moreover, several of these surveys suggest evidence of the level of the neutral real interest rate being time-variant and that it has have fallen over time. This is supported by Ahrend (2008) which cautions that by ignoring the time-varying nature of the neutral real interest rate could yield an upward bias of Taylor-rule interest rates in recent times. Based on the results surveyed in Bernhardsen and Gerdrup (2007) the value for r^* is assumed to be 3 percent for

all countries and being constant over the sample period. This assumption however can yield an upward bias as according to Ahrend (2008) towards the end of the sample, but also downward bias in the beginning of the sample. However, as it is difficult to quantify the possible fall in the neutral real interest rate over time, I follow Ahrend (2008) and use a constant rate.

4.2.1 Estimating the output gap

The last variable in the Taylor-rule is the forecasted estimate of the output gap. The output gap takes the standard definition, as being the percentage deviation of the output from the potential output in country j . Unfortunately the data set from Consensus Economics Inc. (2010b) does not include a forecast for the level of the output gap, so an alternative approach to estimating the gap will be pursued. The data set from Consensus Economics Inc. (2010b) includes forecasted estimates of the unemployment rate, which can be used to construct forecasts of the output gap. The forecasted unemployment rate is unfortunately not available for all of the 13 countries in the analysis, but available for Canada, France, Germany, Italy, Japan, the United Kingdom and the United States. These 7 countries will then be the sample for the Taylor-rule model.

According to general macroeconomic theory there is a ‘straightforward relationship’ between the output gap and the unemployment gap (Krugman and Wells, 2006). This relationship implies that when the real GDP equals the potential GDP, so that the output gap is closed, the unemployment rate will equal the natural rate of unemployment, so that the unemployment gap also is closed. If the output gap is positive then the unemployment rate should be below the natural rate of unemployment, and a negative output gap implies an unemployment rate above the natural rate (Krugman and Wells, 2006).

In order to obtain coefficients that can be used to forecast the output gap based on the unemployment gap, this relationship will have to be modeled using econometrics. In line with the theory above the relationship can be constructed as in equation 4.4.

$$(4.4) \quad y_{j,t} = \beta_0 + \beta_1 u_{j,t} + e_t$$

In equation 4.4 β_0 is the constant term, β_1 is the coefficient measuring how the change in the unemployment gap affects the output gap and e_t is the residual term. The unemployment gap

in equation 4.5 is defined as the difference between the unemployment rate and the natural rate of unemployment, which here is the non-accelerating inflation rate of unemployment (NAIRU).

$$(4.5) \ u_{j,t} = U_{j,t} - U_{j,t}^*$$

The estimation of equation 4.4 will be done by using quarterly values obtained from the OECD database from the 1st quarter of 1990 to the 4th quarter of 2005 (OECD, 2009a). The variables included are the unemployment rate (U_t), the output gap (y_t) and the NAIRU-rate (U_t^*).

The results of the econometric estimation are listed in table 3. The coefficients for the effect of the unemployment gap on the output gap are significant and have the expected signs. A negative unemployment gap where the actual unemployment rate is below the NAIRU-rate yields a positive output gap, and thus a positive unemployment gap yields a negative output gap. This result is in line with the theory presented in Krugman and Wells (2006).

The econometric specification in equation 4.3 indicates a possible problem. By investigating the least squares residuals and the Durbin-Watson values, which are all below the 1,4 threshold, both indicators imply autocorrelation in the econometric estimation (Hill et al. 2008). As the unemployment rate is a persistent cyclical variable, finding correlation between each period is not unexpected. Furthermore, unemployment is a lagging variable in relation to GDP. According to Birch Sørensen and Whitta-Jacobsen (2005) unemployment is more strongly correlated with the GDP of the previous quarter than the current. The performance of the specification could thus have been improved by using a more elaborate dynamic specification, such as including a lagged variable of output gap. The results in table 3 show that the specification in equation 4.4 in general has a relatively high explanatory power indicated by the R^2 values around 0,5, excluding Italy which only show a R^2 of 0,15. The values for Heteroskedasticity and Autocorrelation consistent standard errors (HAC s.e.) have also been included in table 3. They indicate that the reported ordinary standard errors would overestimate the reliability of the least squares estimates, but on the other hand they also indicate that the least square estimator β_1 still is significant when autocorrelation is accounted for (Hill et al. 2008). On the basis of this, the specification in equation 4.3 is kept for the modeling purposes.

Table 3: Output gap estimation results

	Canada	France	Germany	Italy	Japan	U.K	U.S
β_0	0.646**	0,182	-0,059	-0,108	0,419	-0,309*	-0,367**
s.e.	(0,118)	(0,112)	(0,119)	(0,249)	(0,152)	(0,087)	(0,094)
HAC s.e.	(0,172)	(0,2067)	(0,1844)	(0,420)	(0,302)	(0,1634)	(0,161)
β_1	-1,905***	-1,487***	-0,939***	-0,674**	-3,196***	-1,545***	-1,229***
s.e.	(0,0902)	(0,190)	(0,131)	(0,203)	(0,261)	(0,106)	(0,119)
HAC s.e.	(0,1231)	(0,323)	(0,201)	(0,241)	(0,450)	(0,179)	(0,154)
R^2	0,878	0,498	0,487	0,151	0,708	0,776	0,631
DW	0,440	0,216	0,561	0,18	0,471	0,286	0,347
Asterisks indicate level of significance: * (10%) ** (5%) *** (1%)							

Turning to the expectations data and using the specification in (4.4) creates the following estimation procedure for the expected output gap in period t for period t+1.

$$(4.6) \ E_{j,t}(y_{j,t+4}) = \beta_0 + \beta_1 E_{j,t}(u_{j,t+4})$$

$$(4.7) \ E_{j,t}(U_{j,t+4}) - U_{t+4}^*$$

The expected unemployment gap, $E_{j,t}(u_{j,t+4})$, is the difference between the expected unemployment rate in period t for period t+4 and the NAIRU-rate in period t+4. The expected unemployment rate ($E_{j,t}(u_{j,t+4})$) is calculated in the same manner as expected inflation in section 3.2.4. Due to the persistent nature of the unemployment rate the same weights are used in the calculation. The NAIRU-rate is the ex post value from the OECD data set for quarter t+4 and it is assumed here that the policymaker has obtained a forecast for the NAIRU-rate for period t+4 which equals U_{t+4}^* .

4.2.2 The Taylor-rule with expectations data

Now that all variables of the Taylor-rule using expectations data have been defined, the recommended Taylor-rule interest rates are obtained by inserting equation 4.5 into 4.3, yielding equation 4.6, with the parameters taking the following values, $r^*=3$, $\Pi^*=2$ and $\lambda_1 = \lambda_2 = 0,5$.

$$(4.8) \quad i_{j,t}^T = E_{j,t}(\Pi_{t+4}) + r^* + \lambda_1(E_{j,t}(\Pi_{t+4}) - \Pi^*) + \lambda_2(\beta_0 + \beta_1 E_{j,t}(u_{j,t+4}))$$

As with the first model, the next step is to create an output gap conditioned on the outcome of the Taylor-rule calculated from equation 4.8. The output gap for the Taylor-rule model is created under the same assumptions as in the strict inflation-targeting policy rule. This means that the output gaps are created is a deviation from the actual output gap dependent on the deviation of the Taylor-rule interest rate from the actual policy rate. Then this deviation is multiplied with impact coefficient B to create the a Taylor-rule conditioned deviation from the actual GDP.

$$(4.9) \quad \Delta i_{j,t}^T = i_{j,t}^T - i_{j,t}$$

$$(4.10) \quad \Delta Y_{j,t+4}^T = B \Delta i_{j,t}^T$$

The deviation in equation 4.8 is then used to create the corresponding output gap through the Taylor-rule conditioned measure of the real GDP.

$$(4.11) \quad Y_{j,t+4}^T = Y_{j,t+4} * (1 - (\Delta Y_{j,t+4}^T / 100))$$

$$(4.12) \quad y_{j,t+4}^T = ((Y_{j,t+4}^T - \hat{Y}_{j,t+4}) / \hat{Y}_{j,t+4}) * 100$$

5 Results

The results from the two policy-rule models are presented in selected graphs here with the all graphs for the 13 countries presented in appendix A. The first graph for each country compares the interest rate paths of the policy rules with the actual policy interest rate. Due to the restrictions with the available data not all countries are presented with results from both policy rules. The graphs for Canada, France, Germany, Italy, Japan, the United Kingdom and the United States include results from both policy rule models. The second graph for each country shows the different levels of the output gap according to the policy rules and the actual interest rate policy. Both graphs are presented together for each country.

When interpreting these results one should bear in mind that the models based on the strict inflation-targeting rule and the Taylor-rule are simplifications of reality. The results of the policy rules should be seen as basis for theoretical comparison with the actual policy interest rate. Especially the strict inflation-targeting model, with a short policy horizon and high impact coefficients, should be seen as an extreme case for comparison.

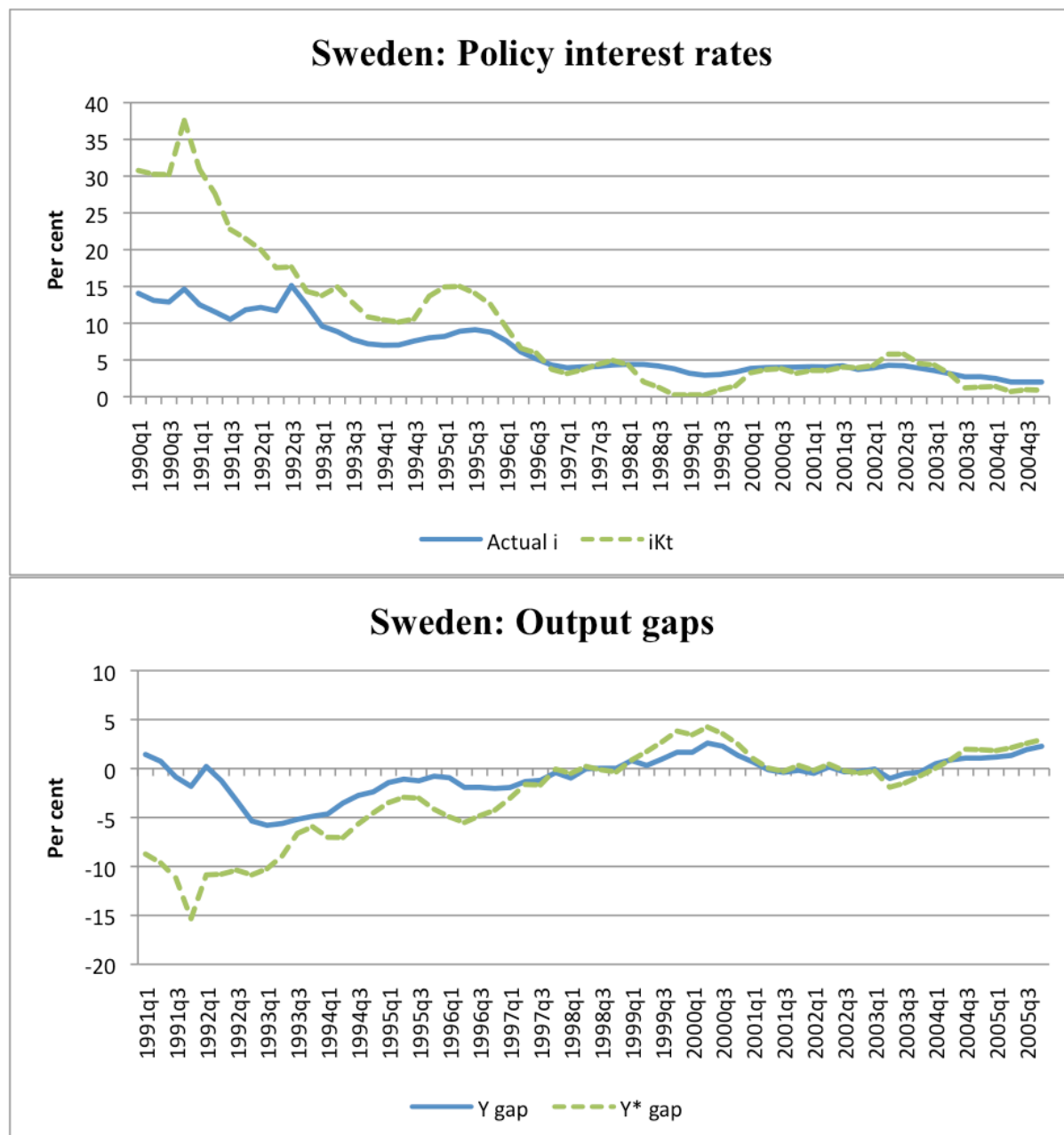
5.1 Output stabilization

The strict inflation-targeting rule modeled in section 3 results in an interest rate path based on the assumption that the central banks aim to keep the inflation variability to a minimum. By following this framework theory states that the central bank will have to allow a high degree of output variability as a trade-off (Svensson, 2002). By inspecting the level of the output gap (y^* -gap) resulting from the strict inflation-target interest rate ($i_{j,t}^K$), each country appears to indicate this trade-off.

Expected and actual inflation in the early 1990s was much higher when compared to the 2000s across the sample. The graphs in appendix A show that inflation ranged between 2-5 percentage points above the inflation target of 2 percent. In order to decrease the expected inflation to target over the policy horizon of one year, most countries would have to set their policy interest rate well above their actual interest rate. In some extreme cases such as for Sweden (Figure 2), $i_{j,t}^K$ reaches a level of almost 40 percent in 1991. The resulting output gap is close to -15 percent the following year. This indicates that if the central bank of Sweden

had followed a more aggressive attempt to control inflation this would have led to a deeper recession.

Figure 2: Sweden policy interest rate and output gap results



Most countries in the sample display this pattern, and would have interest rates in the double digits in order to curb the high inflation according to the strict inflation-targeting rule. According to Svensson (2002) the cost of decreasing inflation from a high level is a deep recession. Investigating the output gaps associated with the strict inflation-targeting rule show that Canada, Finland, Italy and the United Kingdom would have negative output-gaps in

excess of 10 percent, and Denmark, France, Germany, Ireland, the Netherlands, Norway and the United States in excess of 5 percent. It is important to note that all of these countries had negative output gaps based on the actual values, but it appears evident that a strict inflation-targeting approach would lead to considerable worse outcomes.

For periods when the baseline economy experiences a positive output gap and expected inflation level below the target, the strict inflation-target rule appears to recommend an interest rate level which increases the positive output gap. Turning again to Sweden for illustration, the period between 1998 and 1999 had a low expected future inflation of around 1 percent and an output gap on an upward trend. The low expected inflation lowered the interest rate level according to the policy rule yielding a very low $i_{j,t}^K$ level in this period. This in turn gave a higher positive output gap than the baseline output gap. Similar results can be traced for the other countries, where the strict inflation-targeting policy appears to result in higher output gap variability.

This general result appears to further strengthen the result that increased weight on lowering inflation variability relative to output gap variability, will increase the latter.

5.2 The Taylor-rule and actual policy

Using the Taylor-rule analysis with the real-time expectations forecasts data, gave a good opportunity to create a benchmark case of a flexible inflation-targeting policy that yielded some interesting results. Firstly, the Taylor-rule specification used as the policy-rule specified that there is equal weight of importance on stabilizing inflation variability and output-gap variability. This should then imply that the path of the Taylor-rule interest rate ($i_{j,t}^T$) would not demonstrate the same variability as the strict inflation-targeting rule ($i_{j,t}^K$) when expected inflation deviates from target. This is true for all countries where the Taylor-rate is calculated in the earlier part of the sample period. The comparison between the two simple policy rules further demonstrates that a policy that focus exclusively on realizing the inflation target results in higher output gap variability. This result is expected as the Taylor-rule explicitly attempts to stabilize the output gap.

When comparing the three interest rate paths, the actual interest ($i_{j,t}$) rate appears to be located more or less in between the two simple policy rules in the early part of the 1990s for

Canada, France, Germany, Italy, Japan (in 1990-1991) and the United Kingdom. The results indicate that the central banks of these countries demonstrated a more aggressive stance in bringing inflation down in this period than the Taylor-rule implies. Given the assumption that the central banks were operating with an inflation target of 2 percent this aggressiveness seems justified given that expected inflation was well above target in this period (see charts in Appendix A). A plausible explanation for this behavior by the central bank is to avoid the economic costs that are associated with periods of high inflation, and thus create a stable macroeconomic environment. According to Svensson (2002) this is the rationale behind why an increasing number of countries are adopting ‘price stability’ as their primary goal for monetary policy.

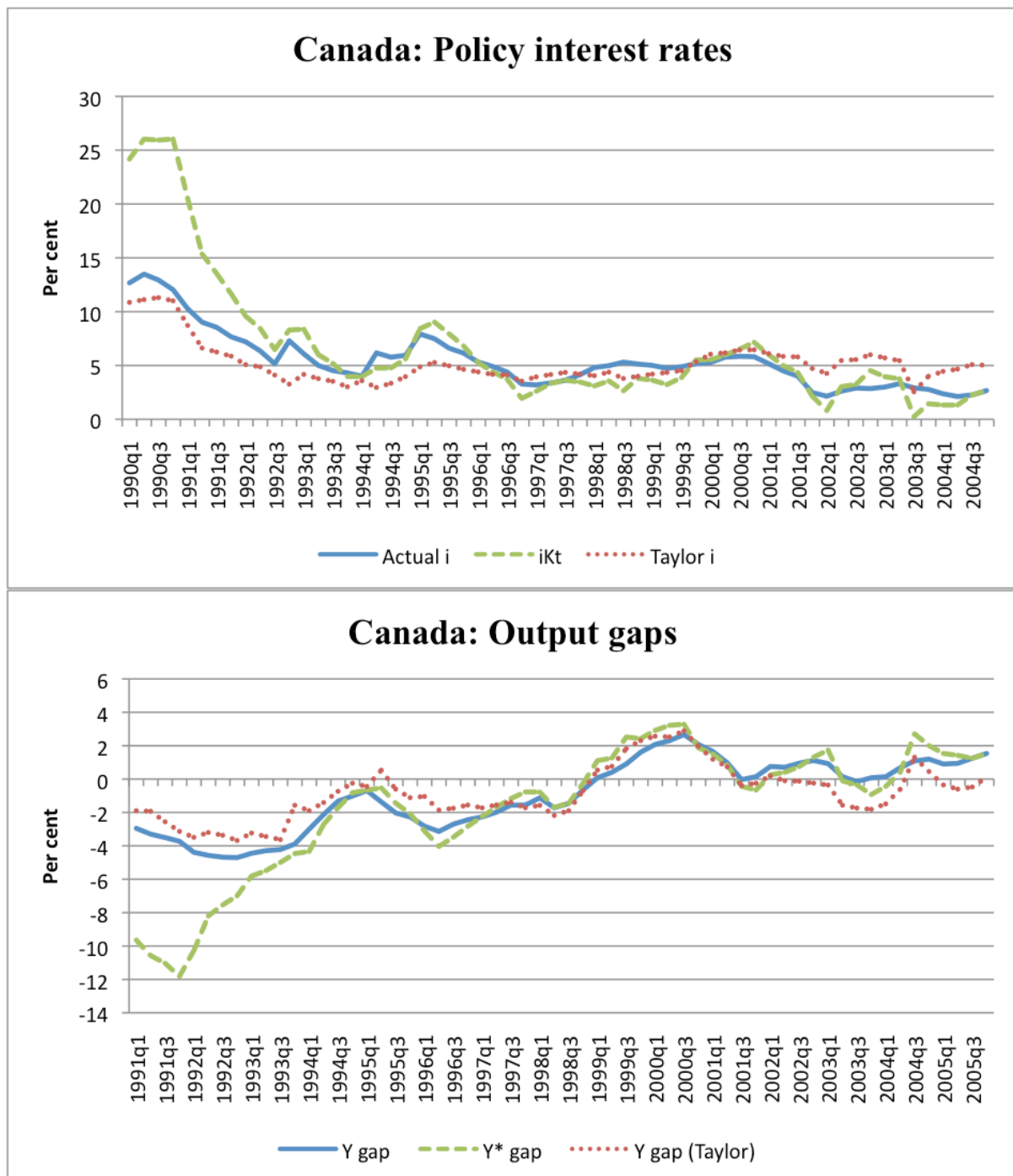
Another related explanation for this anti-inflationary stance is the introduction of an inflation-targeting monetary policy. During the 1990’s several countries adopted inflation targeting as their monetary policy regime⁶. There is a general agreement that central banks in industrialized countries conduct monetary policy in this manner, although not all these banks are necessarily explicit inflation-targeters (Svensson, 2000, 2002). An important aspect of an inflation-targeting regime is anchoring inflation expectations to the inflation target. With expectations anchored at a nominal target, actual inflation tend to revert to target if it was previously drifting away, and monetary policy thus need to be less active in response to these movements (Svensson, 2002). In order to for a central bank to achieve this it will need to gain credibility in conducting policy according to the inflation target, which can only be earned over time. Generally this means that central banks who adopt a system of flexible inflation targeting will have to put more weight on bringing down and stabilizing inflation in the beginning of the new policy regime, and thus also bring inflation expectations down towards the target (Svensson, 2002). In terms of the results both Canada and the UK show this tendency where the actual rate is higher than $i_{j,t}^T$, but below $i_{j,t}^K$ before and during the first years of the inflation-targeting regime.

After the initial years of less flexible inflation-targeting monetary policy (Svensson, 2002), both Canada and the UK succeeded in bringing expected inflation from a high level down to a relative close range around the target of 2 percent in the latter part of the 1990’s (Canada from

⁶ . Examples of this are Australia (1993), Canada (1991), Finland (1993), Israel (1991), New Zealand (1990), Spain (1995), Sweden (1993) and the UK (1992). Bernanke and Mishkin, (1997).

around 1997 and the UK from around 1998). The interest rate paths of both countries show that $i_{j,t}^T$ are following $i_{j,t}$ relatively closely from around 1996 to 2001 for Canada, and 1994 to 2001 for the United Kingdom. This indicates that in this period the Taylor-rule comes close to explaining actual policy and that a focus on both inflation and output has determined monetary policy for these countries in this period.

Figure 3: Canada policy interest rate and output gap results

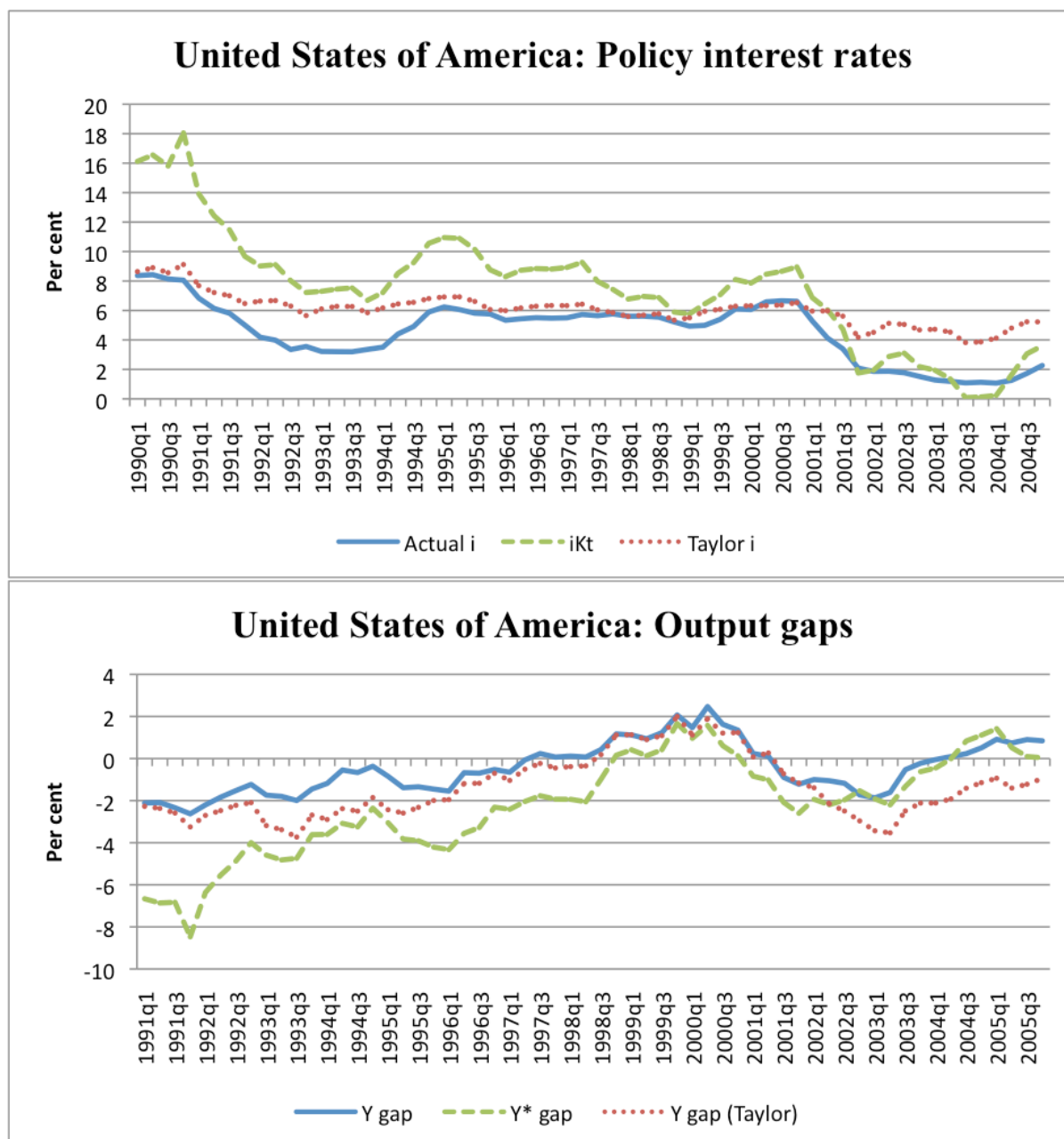


Germany shows similar tendencies of the actual monetary policy as both Canada and the UK. The results show that from approximately 1995 to the end of sample, the Taylor-rule appears to explain the path of the actual policy relatively well. The same can be said for the results for France, where the Taylor-rule interest rate also follows the actual interest rate fairly well.

Another interesting case is found by examining the results for the United States. The Federal Reserve has not formally adopted an inflation-targeting framework, but still have a goal of keeping inflation low and stable (Romer, 2006). In the view of Svensson (2002) the Federal Reserve displays elements of flexible inflation-targeting, although it is not as transparent and consistent as other central banks in conducting this policy. Svensson (2002) also points out that the Federal Reserve appears to have a relative large weight on output gap stabilization. Comparing the interest rates and the output gaps for the U.S. seems to confirm this. The actual policy rate ($i_{j,t}$) is consistently lower than both $i_{j,t}^T$ and $i_{j,t}^K$ until the end of the sample, where it is below $i_{j,t}^T$. This results in an actual average output gap that is smaller than the policy rules.

For the period from 2001-2005, the interest differential between $i_{j,t}$ and $i_{j,t}^T$ was relatively large. An interesting debate has surrounded this result as these years preceded the financial crisis, and the Federal Reserve has been criticized for conducting a to ‘loose’ monetary policy leading to the crisis (Kannan et al. 2009). The criticism follows the line that $i_{j,t}$ deviated too much from a Taylor-rule, and if it had not the crisis could have been avoided (Kannan et al. 2009). It is not within the scope of this paper to investigate the validity of this criticism. As can be seen from the results, $i_{j,t}$ is considerable below $i_{j,t}^T$ in this analysis, which indicates that actual policy was ‘looser’ than the Taylor policy-rule would have recommended.

Figure 4: USA policy interest rate and output gap results



Similar results can be traced for France, Italy and the UK towards the end of the sample. Interestingly, actual policy is closer to the strict inflation-targeting rule in this period. This could indicate a change in the emphasis on the relative target weights, however it is more likely that this is due to relatively small deviations of expected inflation from target. Because of the model specification of the strict-inflation targeting rule this convergence of the two rules is expected when expected inflation move closer to the target.

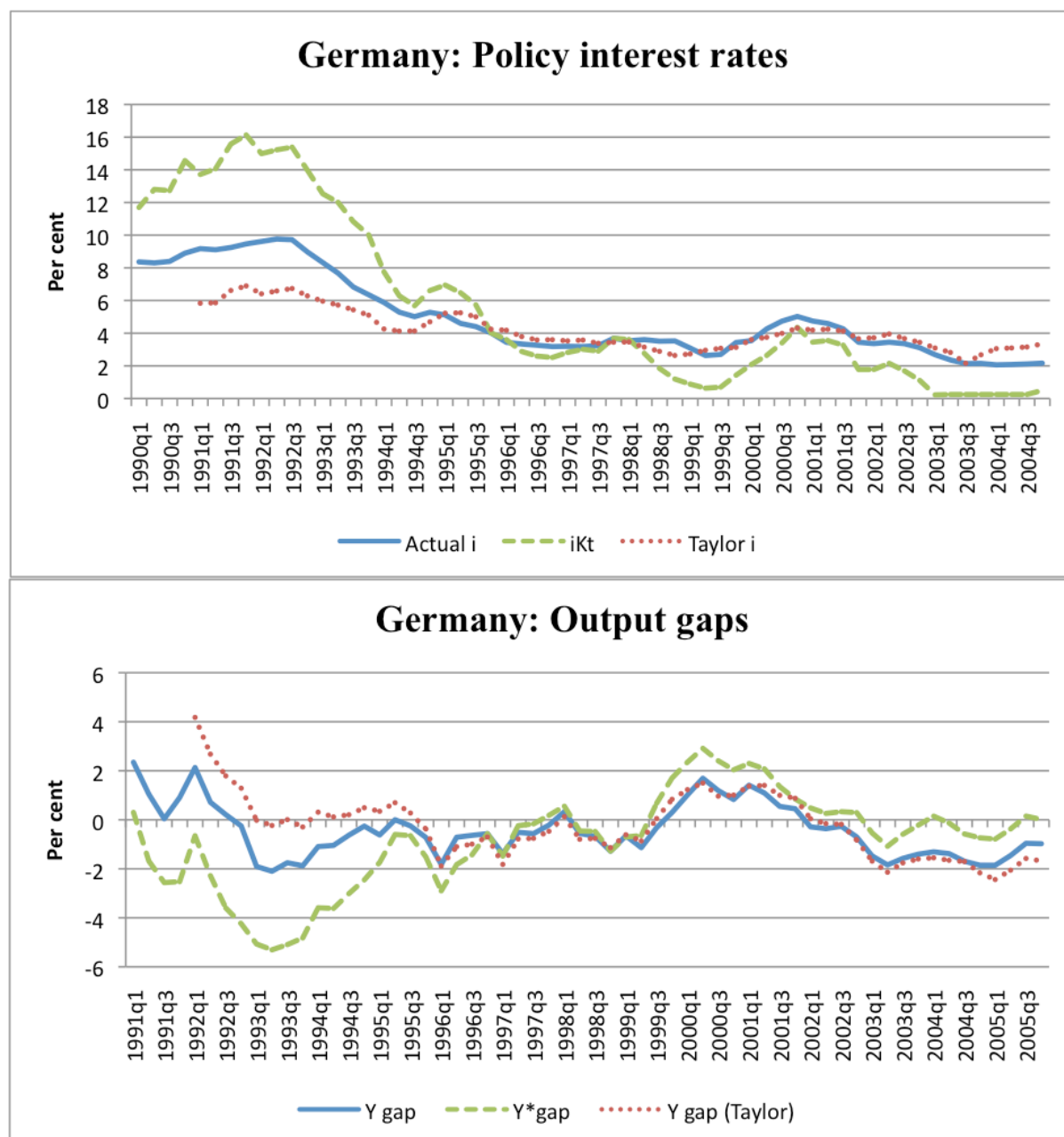
The case of Japan is special with respect to monetary policy. Japan experienced a recession coupled with expected deflation in this period. Efforts to increase inflation expectations and get the economy back on track is impaired by the lower zero bound of interest rates (Svensson, 2002). The results show that the strict inflation-targeting policy rate reacts quicker than the policy rate to raise inflation expectations, and stay at 0,25 percentage points throughout most of the time-period. The Taylor-rule interest rate appears to react slower than the actual policy rate in decreasing the interest rate level, most likely due to the effect of output gap stabilization. This indicates that the actual policy rate put more emphasis on raising inflation expectations by lowering the interest rate. Svensson (2002) argued that finding alternative solutions to bringing Japan out of this recession remained the world's most urgent monetary policy task at the time.

5.2.1 Monetary policy in the Euro area

With the introduction of stage three of the Economic and Monetary Union (EMU) in 1999 individual member countries transferred the conduct of monetary policy to the ECB (ECB, 2003). As the individual member states are no longer able to conduct monetary policy according to domestic determinants, such as inflation and output, the ECB faces some policy challenges. This is mainly finding and balancing macroeconomic policies that are appropriate for the individual countries and the euro area as a whole (ECB, 2003).

The interest rate paths calculated by the policy rules in this analysis are based on expected inflation for the individual countries in the euro area. This allows the analysis to compare policies based on the interest rate rules with domestic determinants and the actual policy conducted as part of the EMU. For France and Italy the actual policy yields the lowest average output gap in this period when compared to the policy rules. For Germany, Ireland and the Netherlands the results show that the actual policy does not necessarily result in the lowest average output gap. For Germany this is the case between 2002-2005, for Ireland between 1999-2005, and for the Netherlands between 1999-2001 and 2004-2005. These result show that the strict inflation-targeting rule yields a lower average output gap. The implication of this is that for these countries monetary policy based on domestic inflation expectations yields better results compared to the actual policy. This result appears to confirm the difficulties facing the ECB in conducting monetary policy for the whole euro area.

Figure 5: Germany policy interest rate and output gap results



5.3 Interpretation of the results

During the sample period for the analysis, the literature seem to agree on the fact that monetary policy in industrialized countries has been determined by a goal of low and stable inflation and output stabilization. This flexible inflation-targeting approach in the form of the Taylor-rule appears to fit well with the data where the analysis has been able to compare the

actual interest rate with both policy-rules. The Taylor-rule interest rate moves closely with the actual interest rate during long parts of the sample period for most countries.

A notable exception is the United States. For the United States it appears that the actual policy was consistently lower than the Taylor-rule interest rate throughout the sample period. However, as discussed in section 5.2 it is believed that the Federal Reserve placed more weight on stabilizing the output gap. By investigating the output gaps it is evident that the actual output has the lowest variability compared to the policy rules. This result is not surprising as central banks conduct policy according to fundamentals in their respective economy. The relative weights on the policy targets that are appropriate in the United States may not be appropriate in the United Kingdom. The brief investigation on the conduct of monetary policy in the EMU further illustrates this point.

It appears from the comparison between the rates that there has been a change in the relative weight and emphasis on the two goals during the period of analysis. The higher policy rates at the beginning of the sample period indicate that bringing down the inflation rate was put more weight on when determining monetary policy. This follows the main target of low and stable inflation, and indicates that the emphasis on inflation stabilization was higher then. Although this departs from the weights proposed in the Taylor-rule, the increased emphasis on inflation was still arguably consistent with flexible inflation-targeting. Bringing high inflation down in the early period of a flexible inflation-targeting regime is a necessary condition for the regime to function properly (Svensson, 2002). Flexible inflation-targeting countries such as Canada, Germany and the UK show this tendency. Furthermore, as inflation expectations have come down in recent years the relative weights on the two targets appear to have shifted. Creating stable economic conditions through the stabilization of the output gap appear to have gained more importance alongside low and stable inflation.

The model of strict inflation targeting show that exclusively focusing on reducing expected inflation, results in increased output gap variability for the countries in the analysis. In the comparison with the Taylor-rule interest rate, the strict inflation-targeting rule appears to be quite different from actual monetary policy. This result further indicates that actual policy in this period is best explained by flexible inflation-targeting.

5.3.1 Possible extension of the models

The policy-rule models in this paper are both kept basic in order to create simple and clear outcomes. Modeling the conduct of monetary policy and the effects on the economy as a result of policy changes creates challenges due to its complex nature. As discussed earlier in the paper the expectations data present a possible problem of being based on assumed changed policy. In this paper this presumption has not been taken into account, and this possibly creates the problem that the expectation data are not a true representative measure of unchanged policy. In order to incorporate this aspect the models could include the expected value of future policy rates when calculating the current policy-rule rates.

A further possible extension is to make the models more dynamic by allowing for the effect of monetary policy to last for more than one period. An example of this could be to allow for the interest rate to impact on two following periods. However, this might not lead to much difference in the actual outcomes. If the interest rate in period t had an effect over two periods, say half in $t+4$ and half in $t+5$, the expected inflation rate in period $t+1$ for period $t+4$ would be lower as a result. But on the other hand, keeping the policy horizon at $t+4$, this would lead to a stronger response in period t and lesser response in period $t+1$. It is likely that the average of these interest rates would be close to the current rates, so the more basic specification has been kept for the modeling purposes.

6 Conclusion

The determinants of monetary policy have occupied a considerable number of researchers within the field of macroeconomic policy in the recent decades. The changes in theory and practice stemming from both research and experience are of great importance both for individual countries and the international economy as a whole. Earlier policies such as targets for money growth in the 1970's and intensified efforts to reduce inflation in the 1980's has sprung from this research and been adopted by policymakers (Bernanke and Mishkin, 1997). This indicates that the determinants of monetary policy have changed during these decades. The main focus for monetary policy over the last two decades has been low and stable inflation. In addition to this, the extent that monetary policy can stabilize output in the short-run has become an important determinant of actual policy (Svensson, 2002).

This paper I have attempted to investigate the determinants of monetary policy between 1990 and 2005 by comparing the actual policy interest rate with the outcomes of two simple policy rules. The policy rules used are one based on the strict inflation-targeting approach and the other on the flexible inflation-targeting approach. By comparing the actual interest rate to these policy rules, this should indicate the emphasis of the central banks policy targets. In order to make this comparison this paper has used real-time forecast data for the time period, thus creating policy interest rates that are based on relevant information at the time.

A general conclusion that can be traced by comparing the policy interest rates during the sample period is that monetary policy was largely determined according to the principles of flexible inflation-targeting. For the countries included in the Taylor-rule analysis, this policy interest rate path was close to the actual policy path for large parts of the period investigated. It is also found that when the actual interest rate deviated from the Taylor-rate in the early 1990s this could be related to the implementation of flexible inflation-targeting. However, as the inflation expectations at the time were high central banks appear to have put more emphasis on reducing the inflation rate. This emphasis appears not to have been without some consideration for the output gap, as actual policy did not come close to the strict inflation-targeting rule. Furthermore, the results conclude that following the strict inflation targeting rule would lead to increased output gap variability across the whole sample.

Based on the conclusions drawn from the analysis and the general consensus, flexible inflation targeting appears to be the preferred approach for most central banks in industrialized countries (Svensson, 2002). However, with background in the recent financial crisis, the two primary goals of monetary policy are being challenged as leading to a too narrow approach to prevent a crisis of this nature (Kannan et al. 2009). As the conduct of monetary policy appears to be changing over time, it is possible that this criticism may result in different or added goals and emphasis for future monetary policy to take into account.

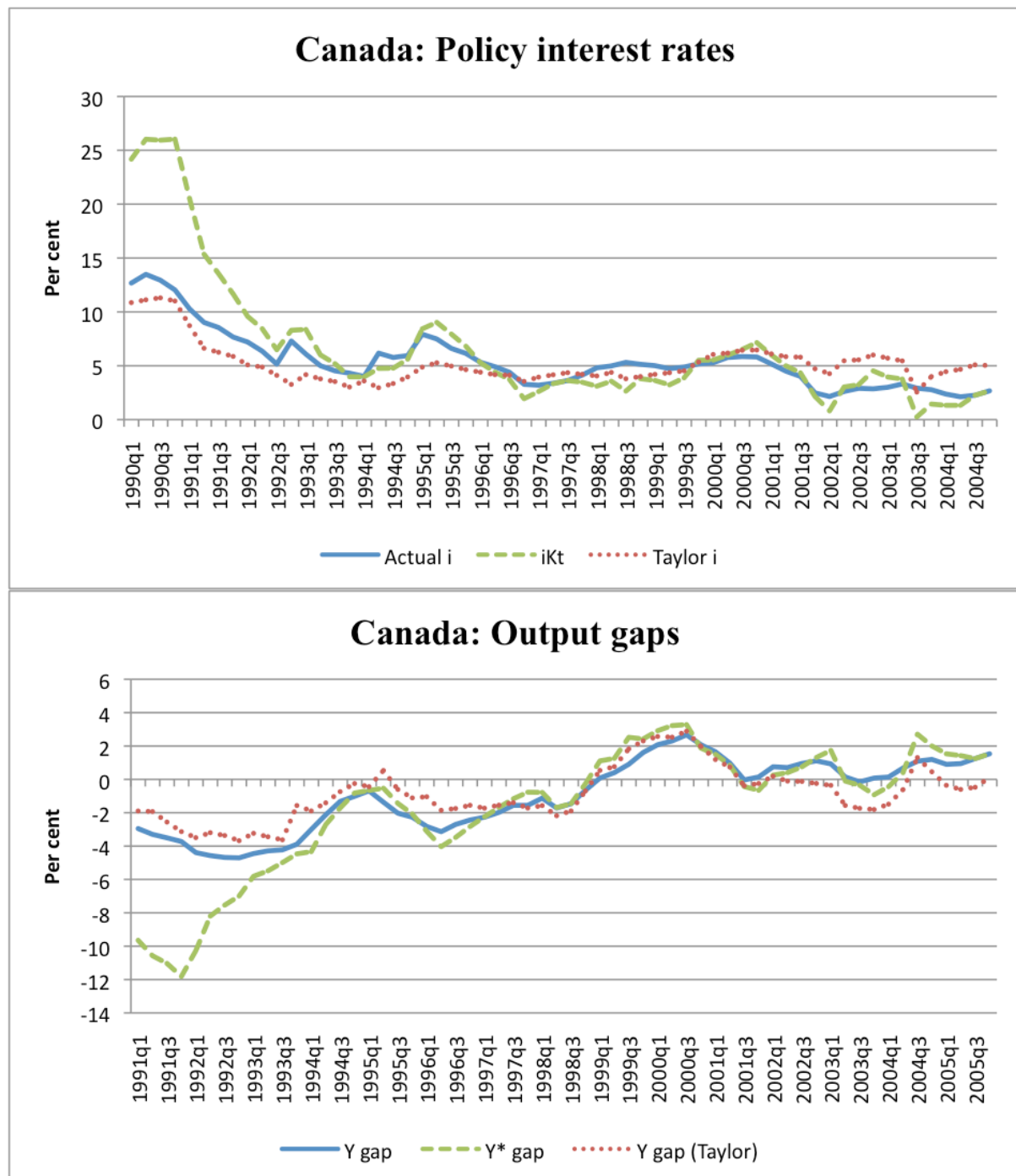
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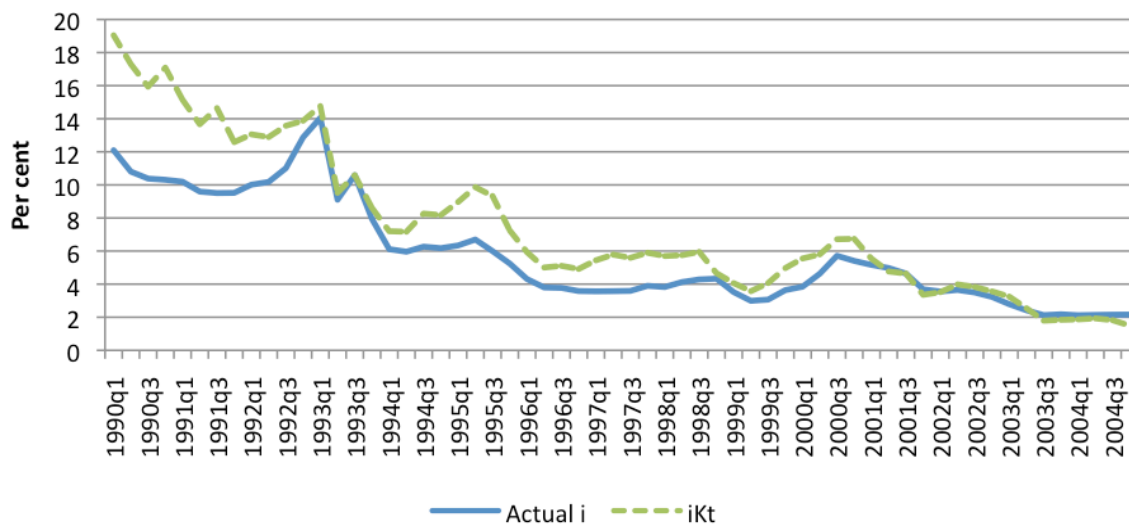
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Appendix A: Figures

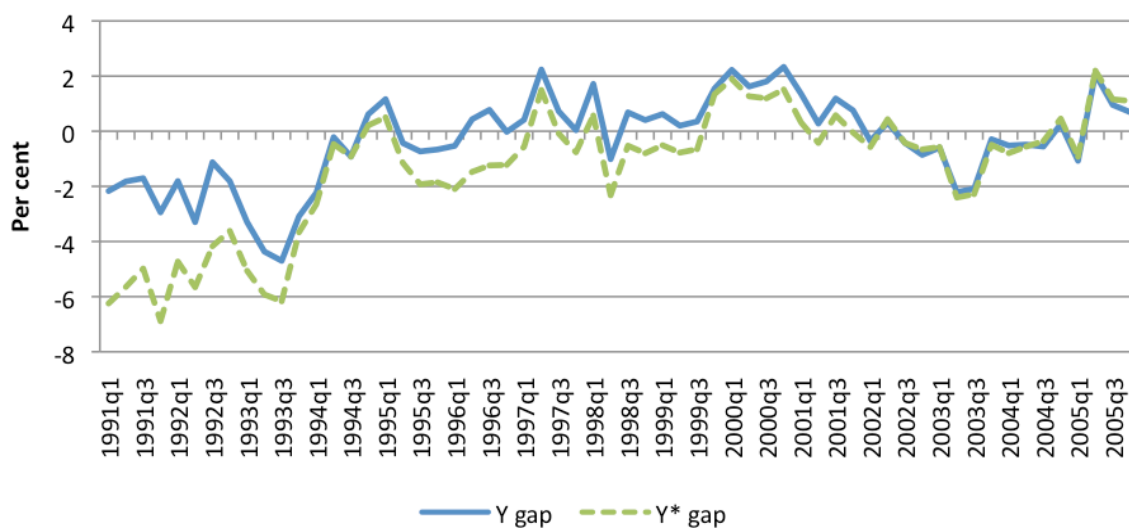
Figure series 1: Policy interest rates and output gaps



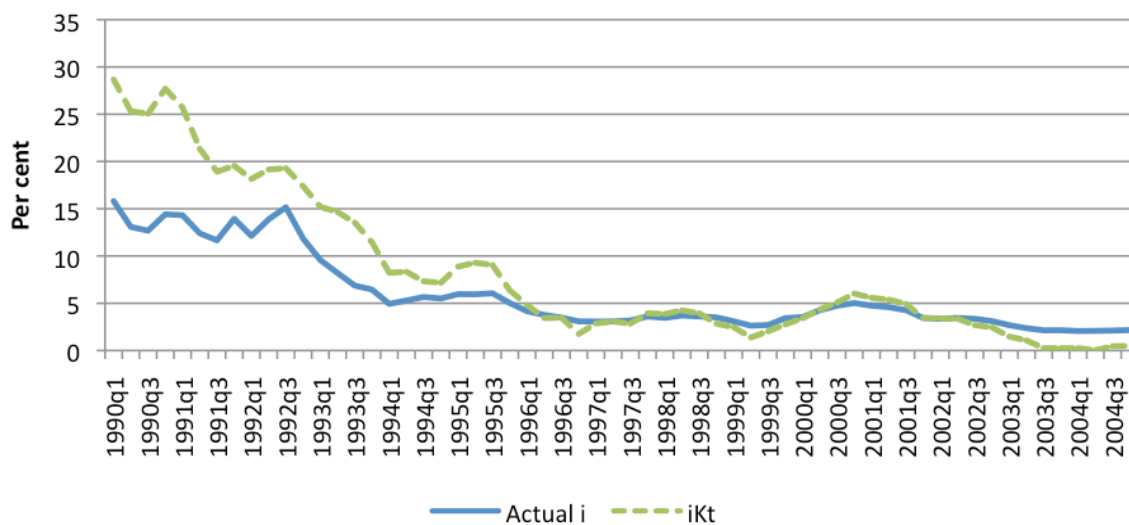
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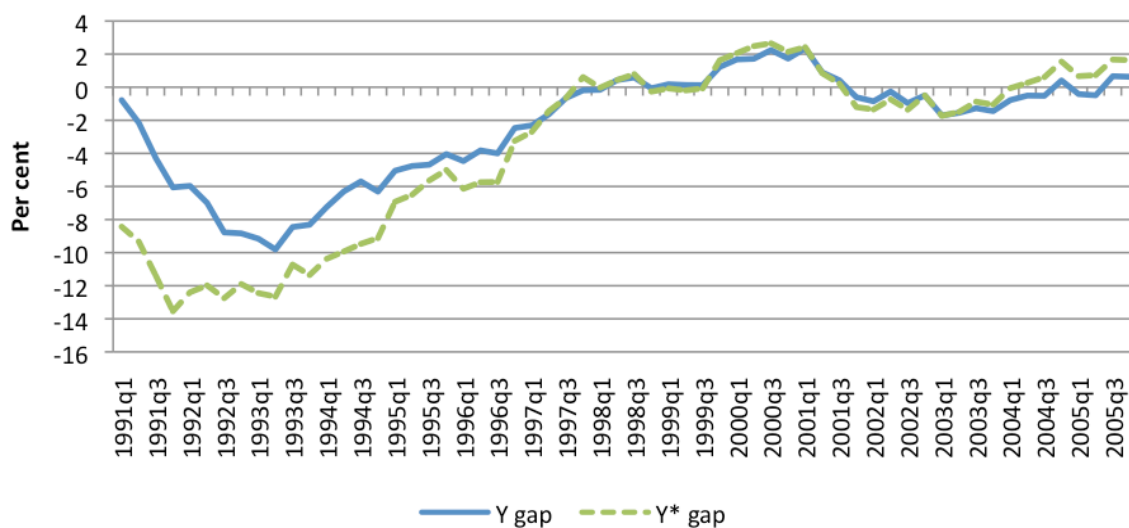
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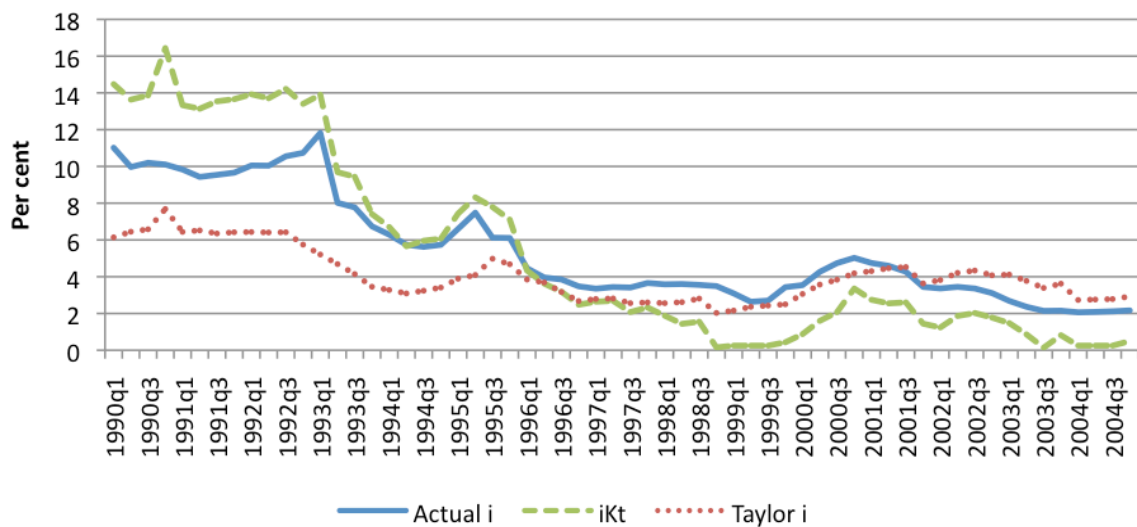
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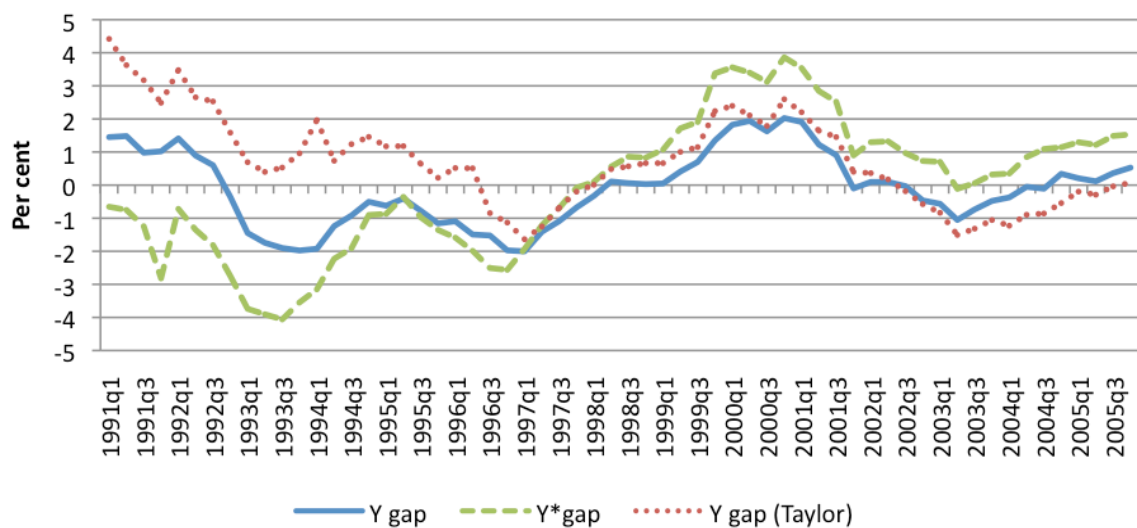
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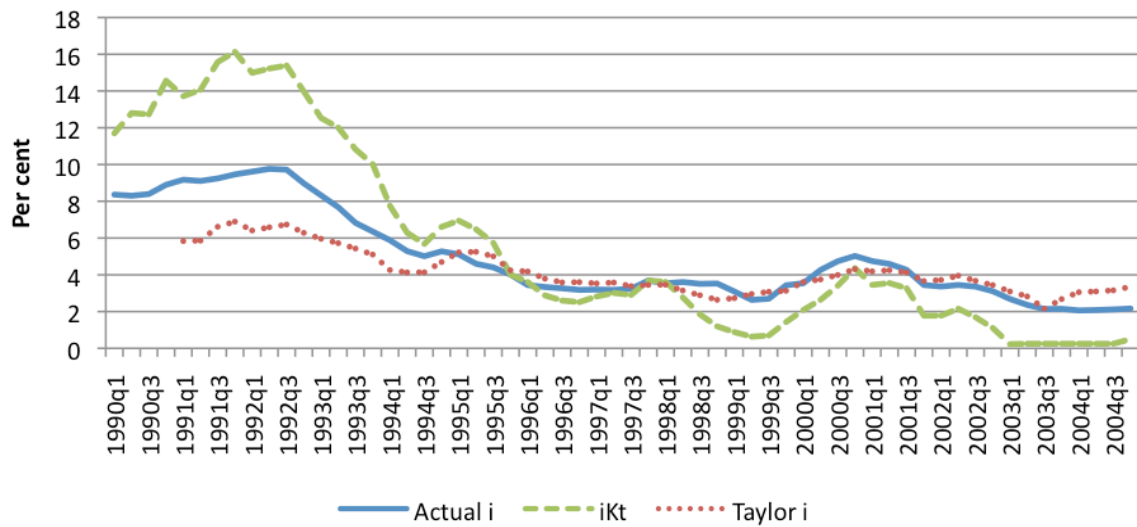
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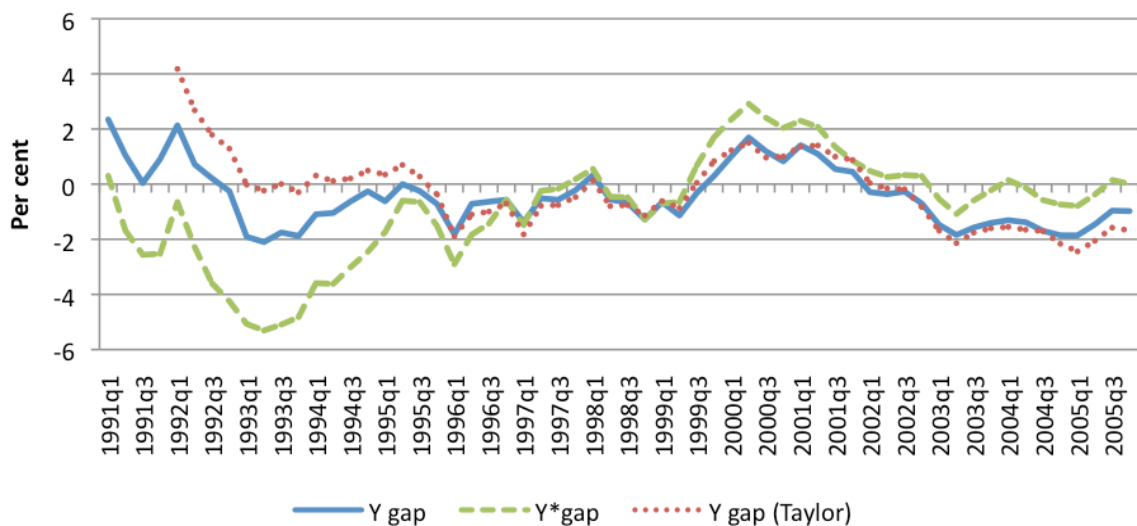
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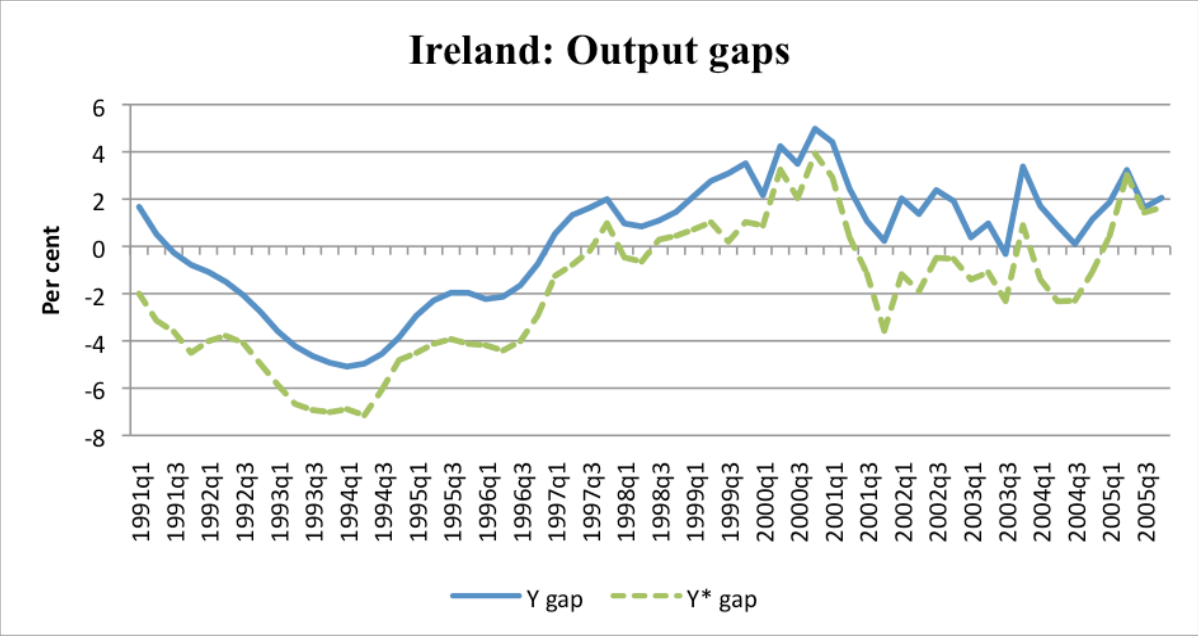
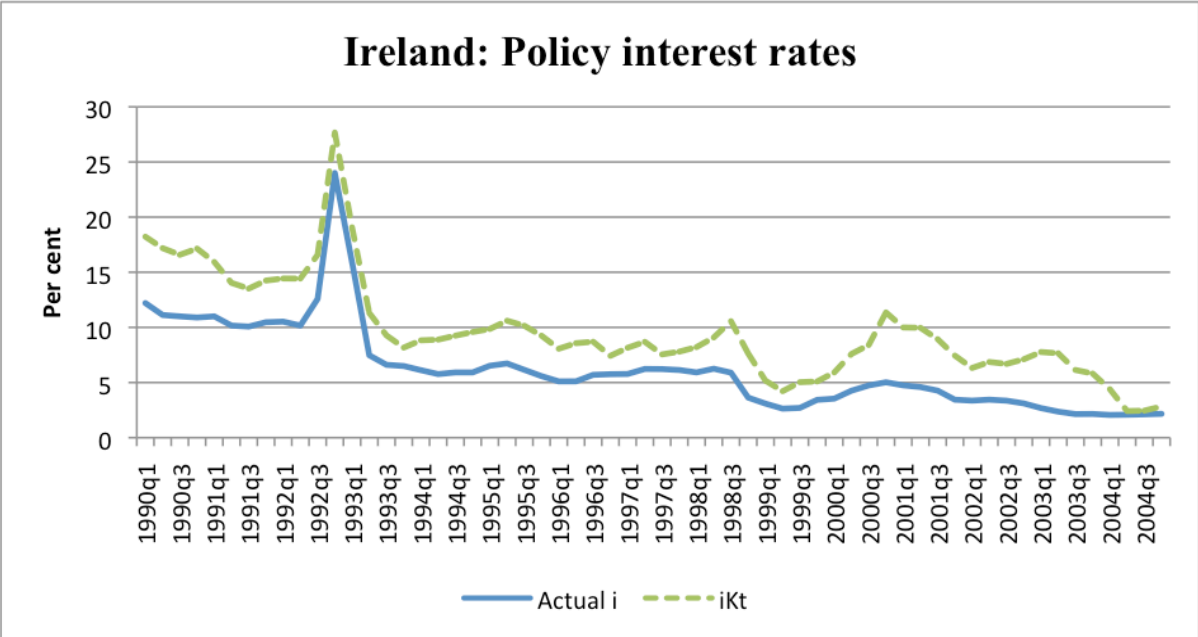


Germany: Policy interest rates

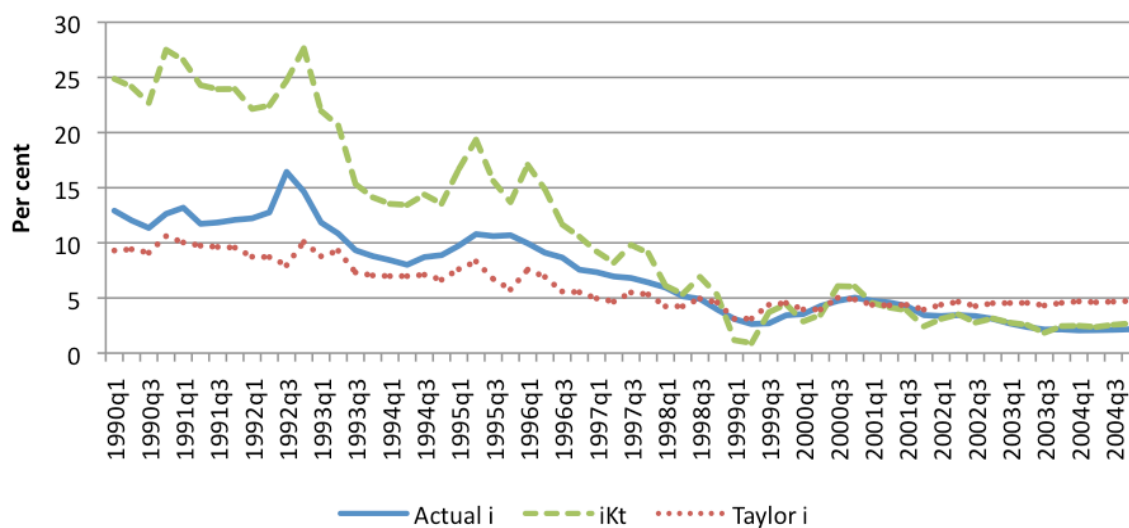


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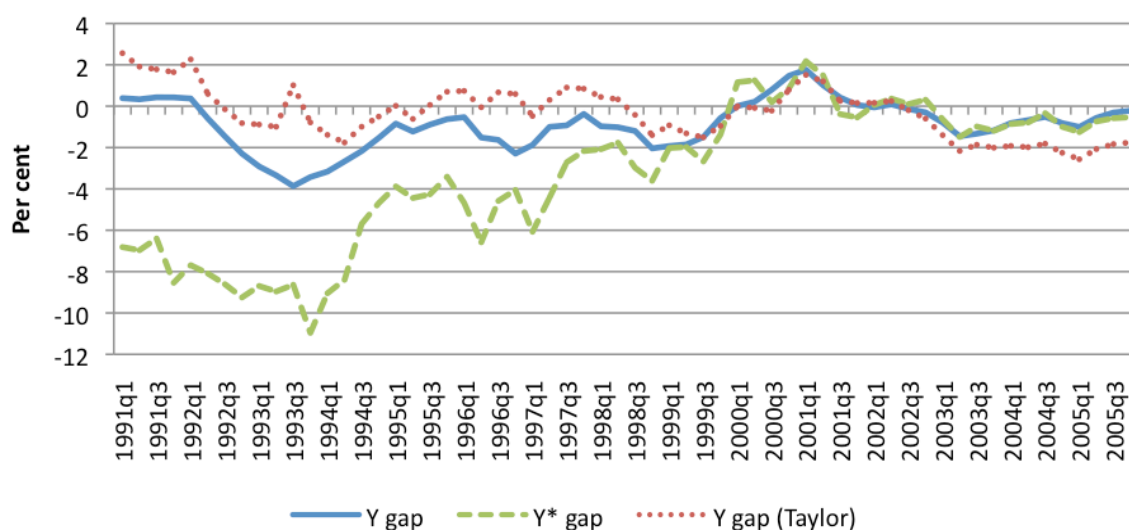




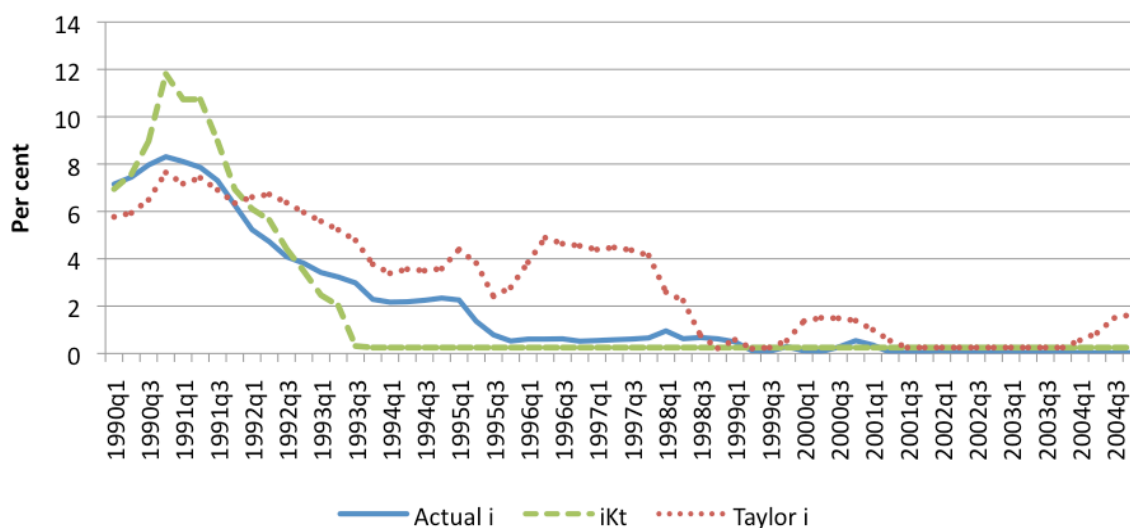
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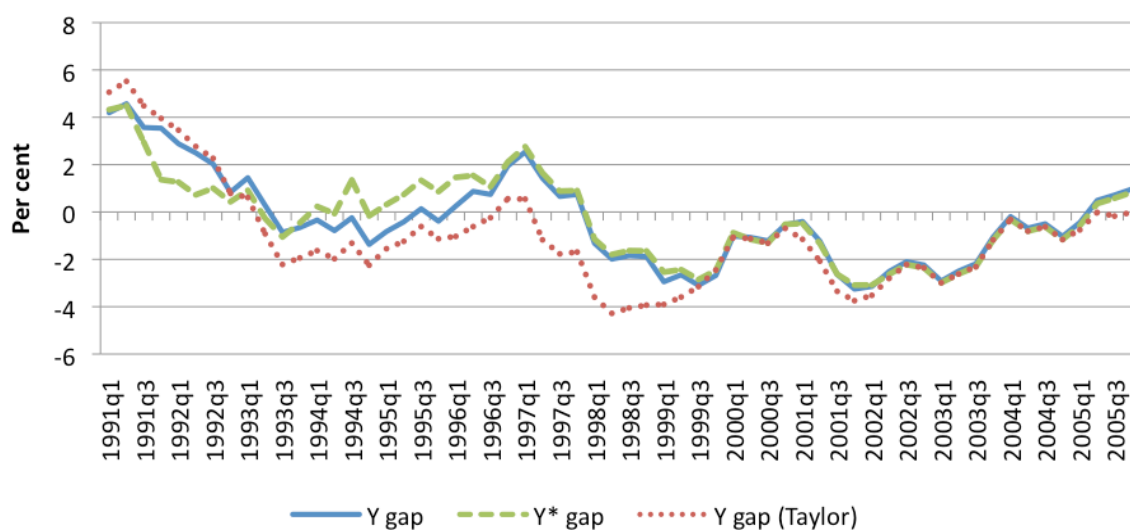
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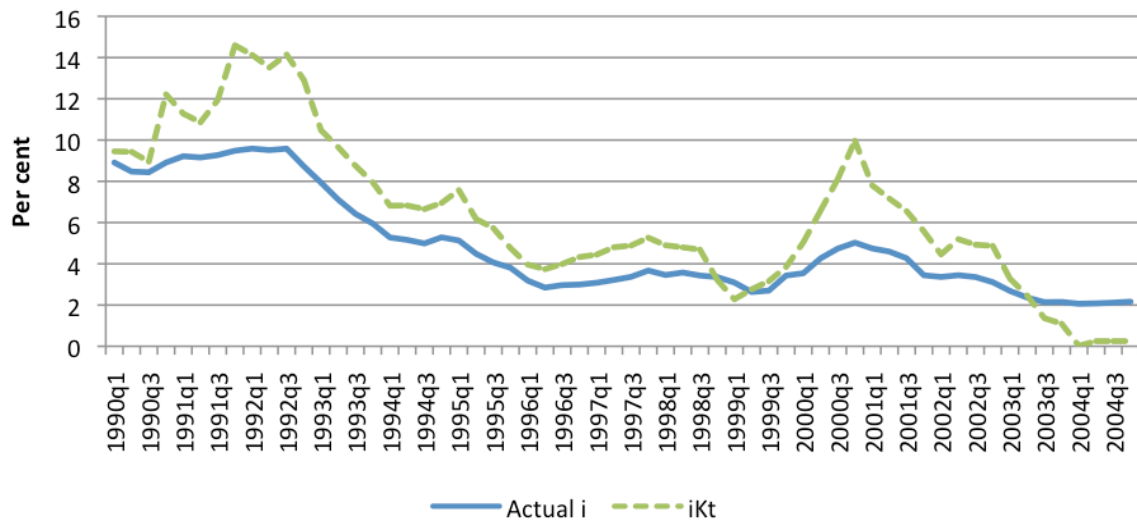
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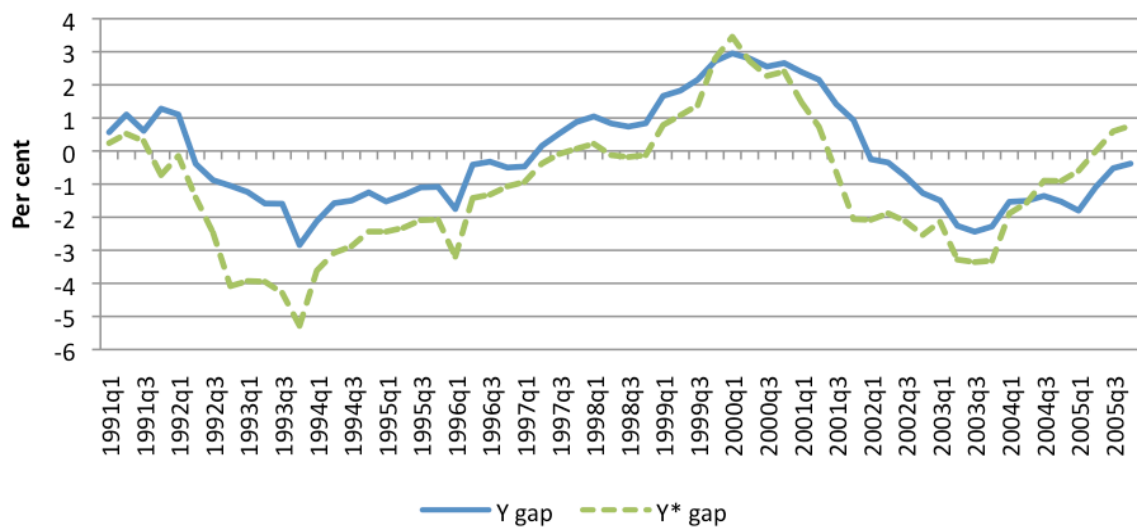
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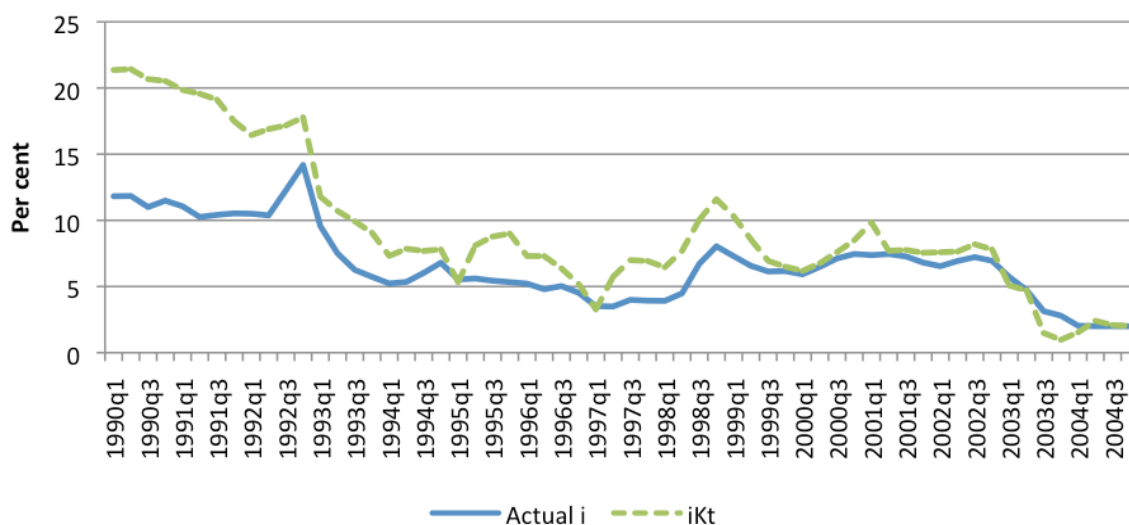
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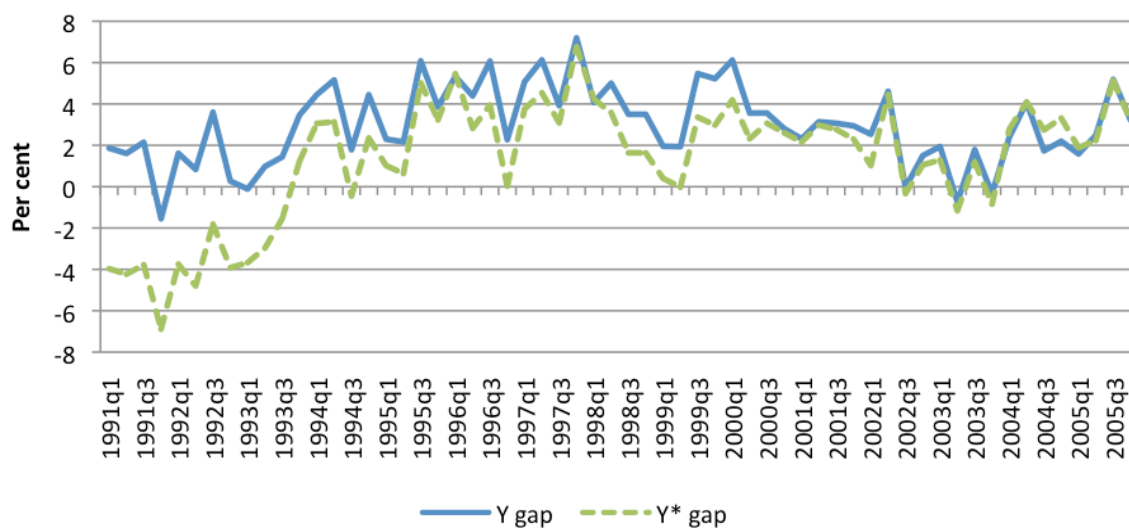
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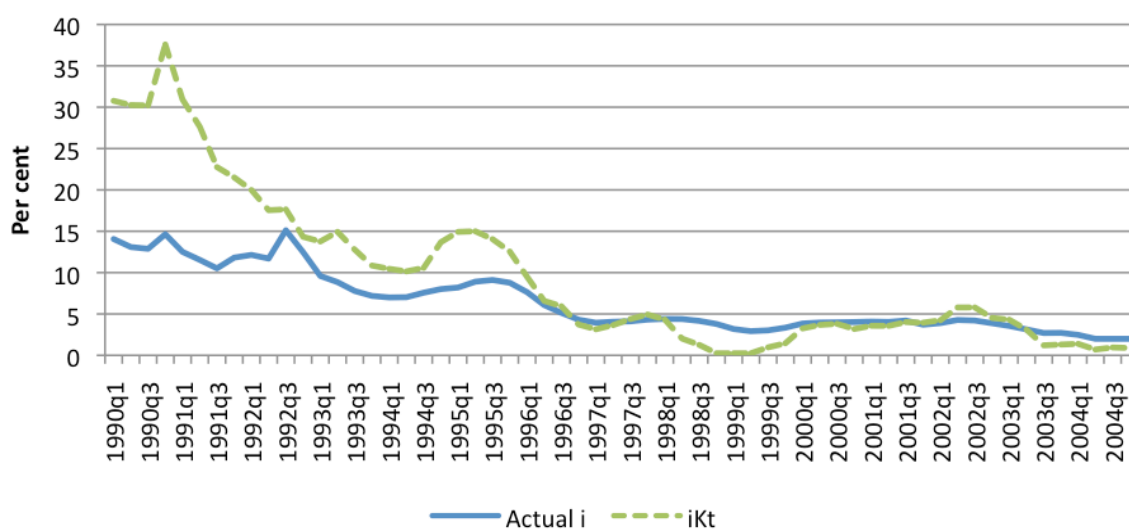
Norway: Policy interest rates



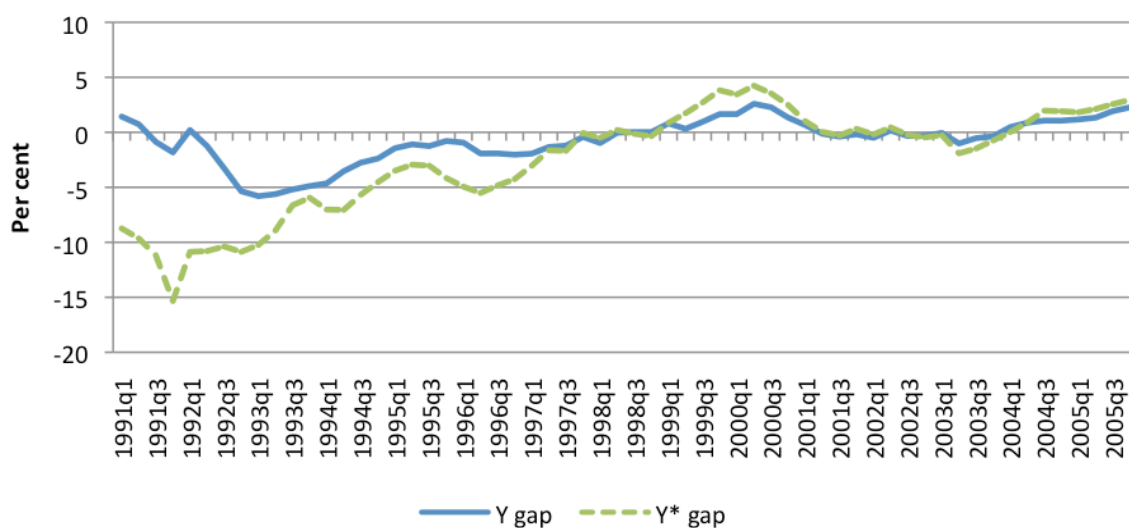
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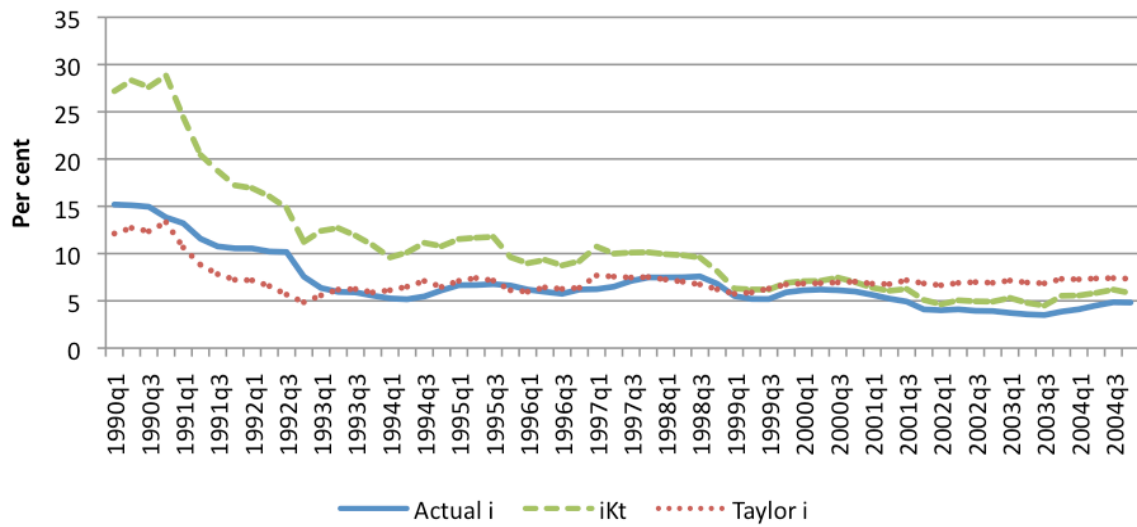
Sweden: Policy interest rates



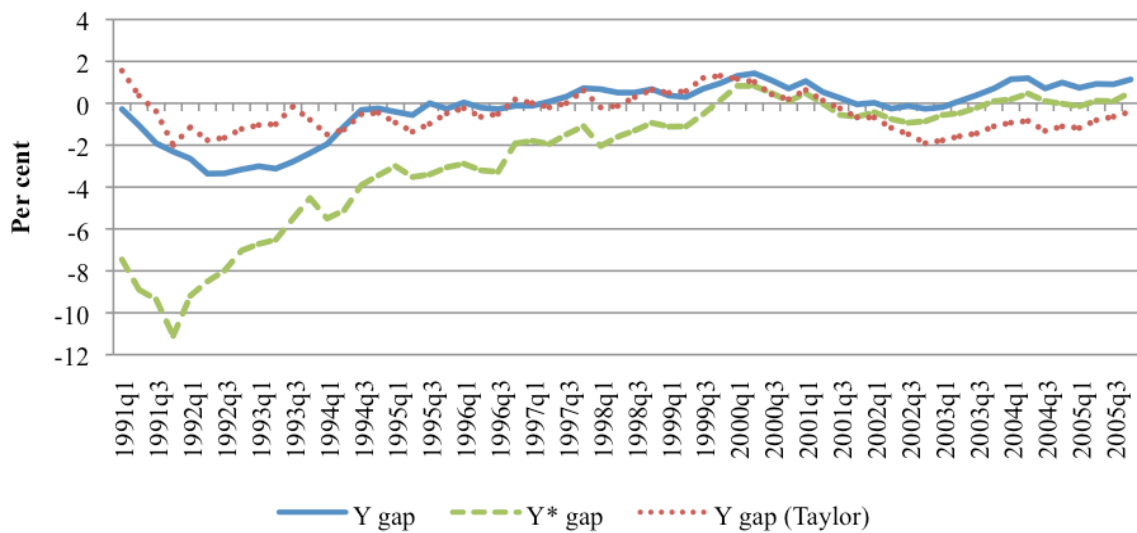
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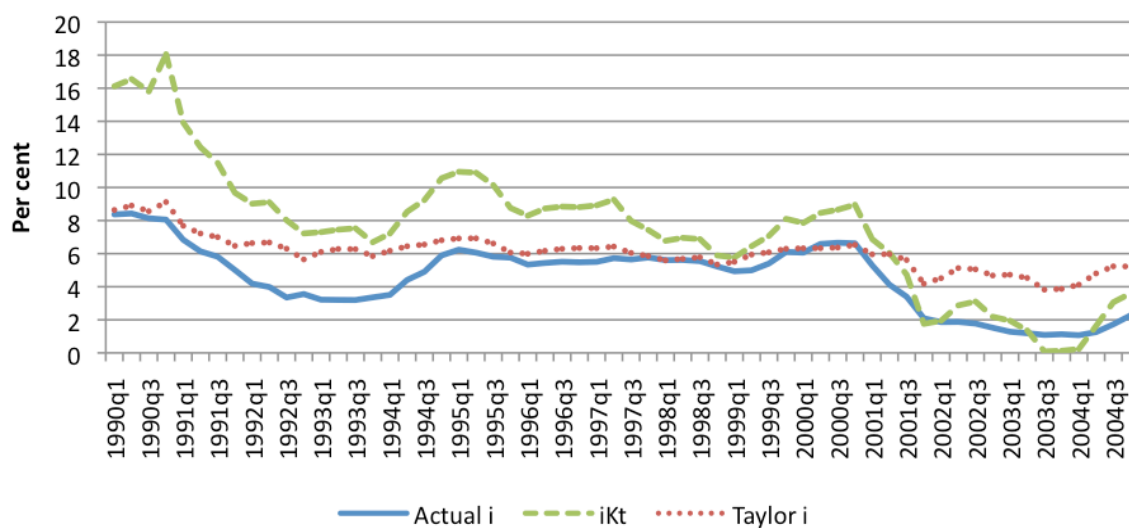
United Kingdom: Policy interest rates



United Kingdom: Output gaps



United States of America: Policy interest rates



United States of America: Output gaps

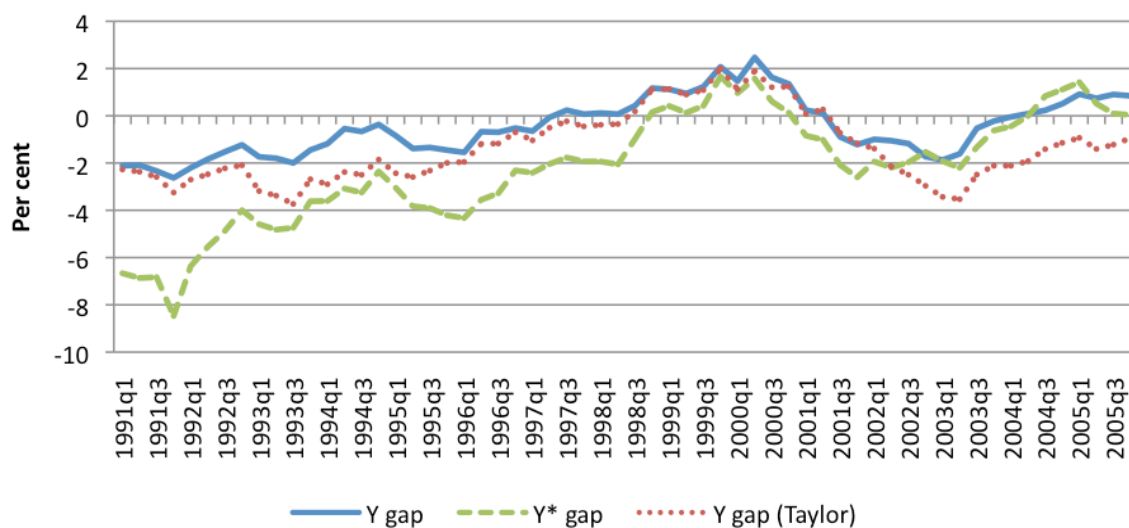
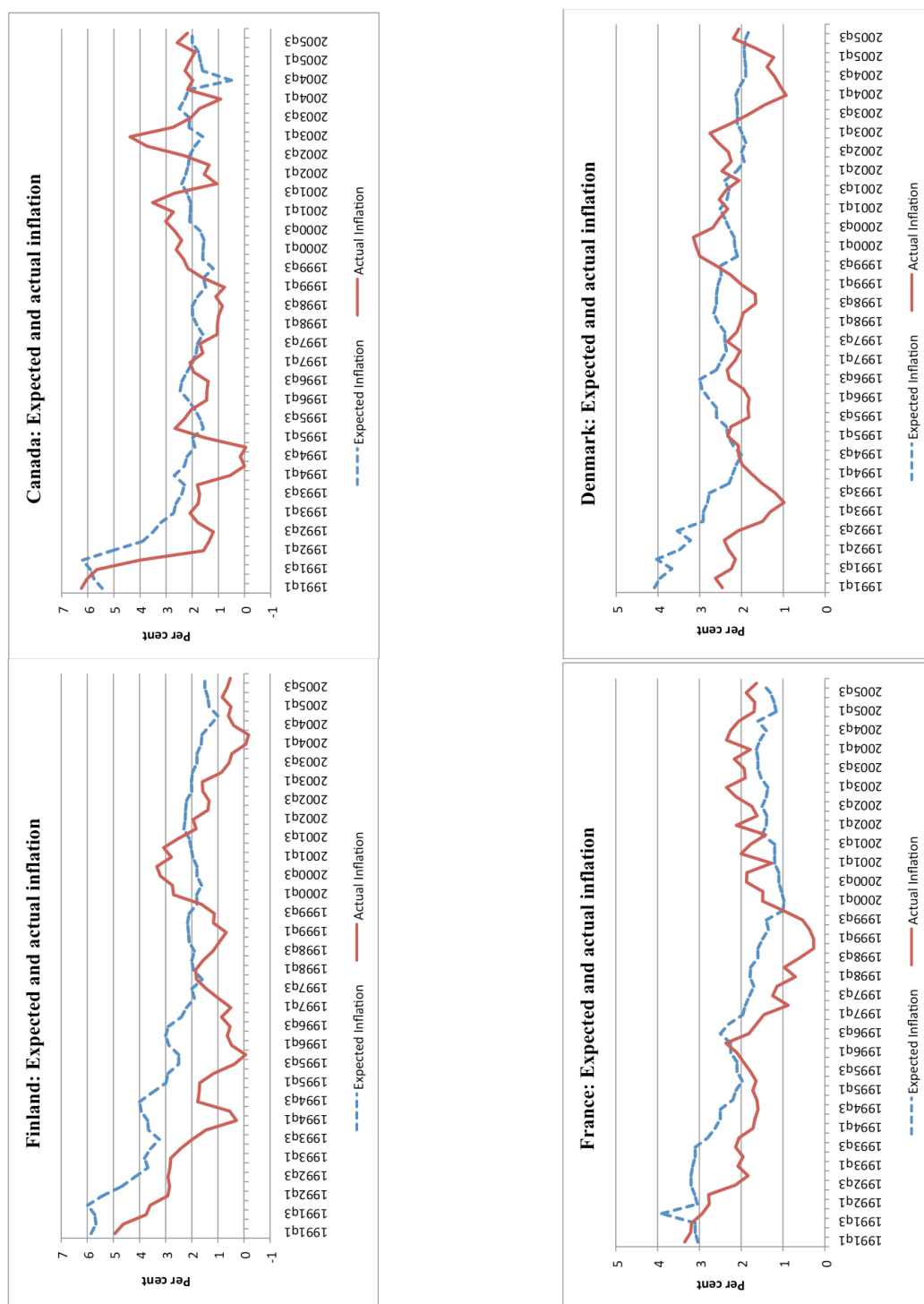
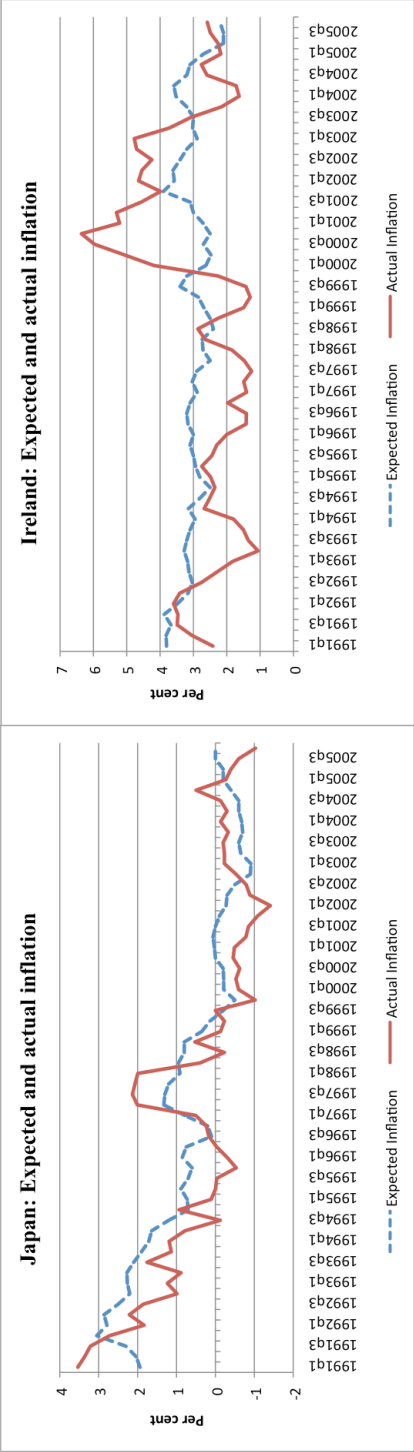
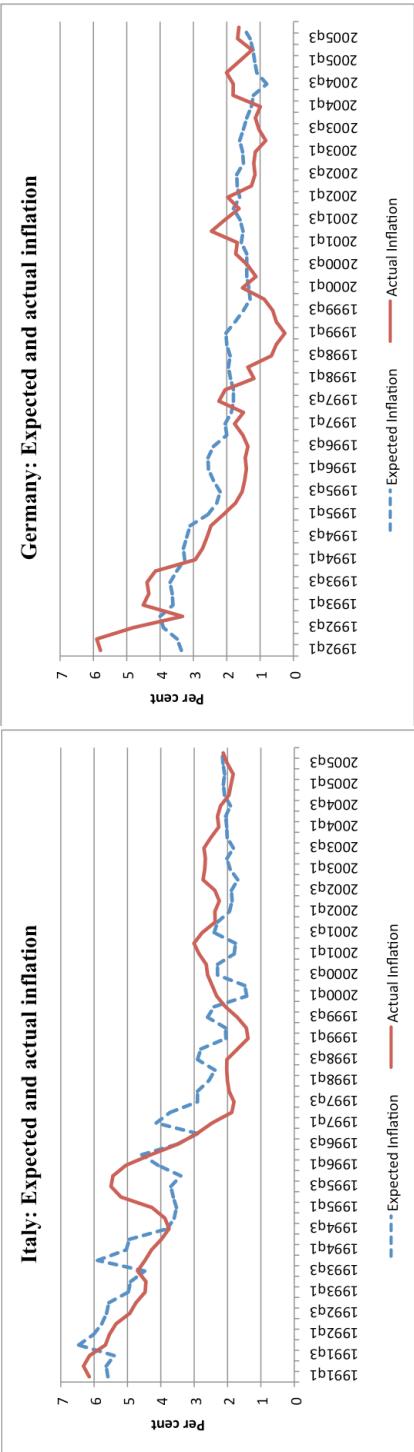
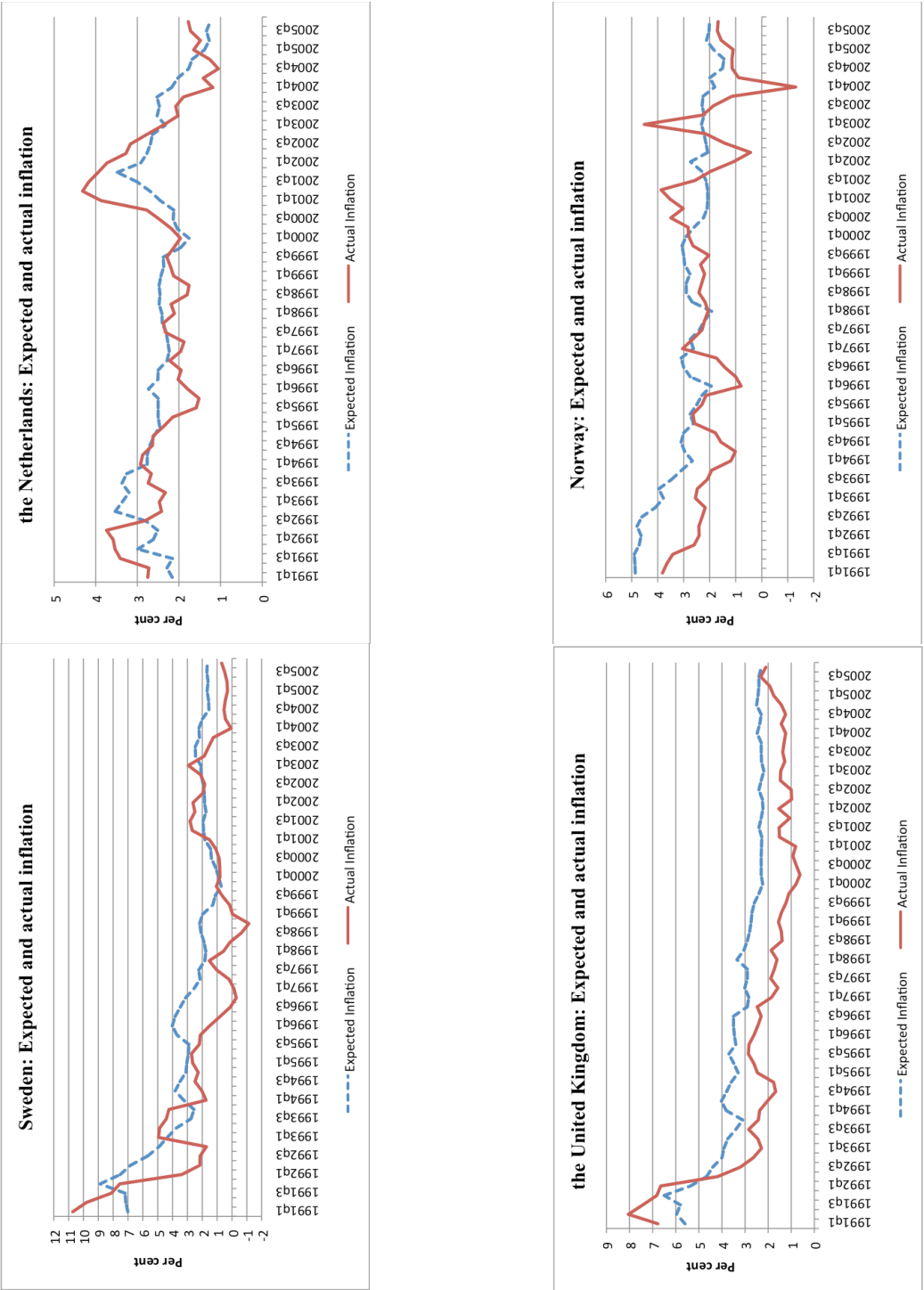


Figure Series 2: Expected and actual Inflation.⁷



⁷ Expected inflation is calculated from the Consensus Economics Inc. data set (2010b), using the method described in section 3.2.4. Actual inflation is calculated as the increase in the consumer price level over the previous 4-quarters. $\Pi = \ln(P_t) - \ln(P_{t-4}) * 100$.





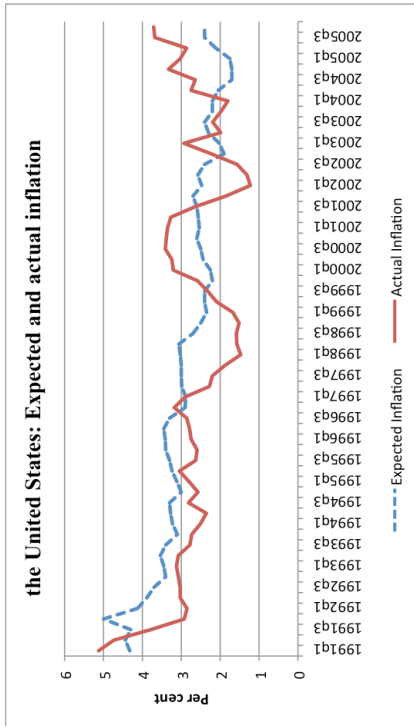
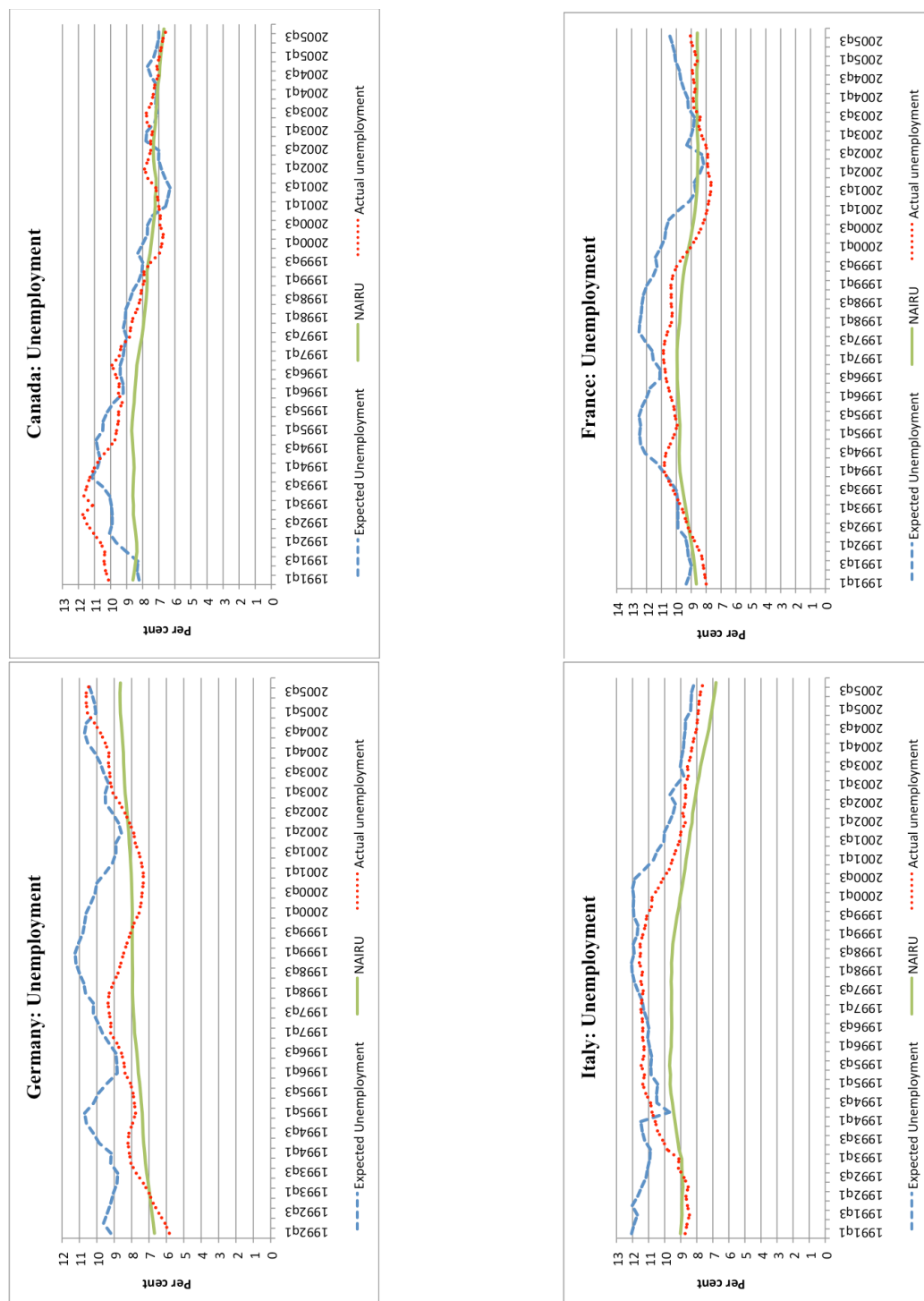
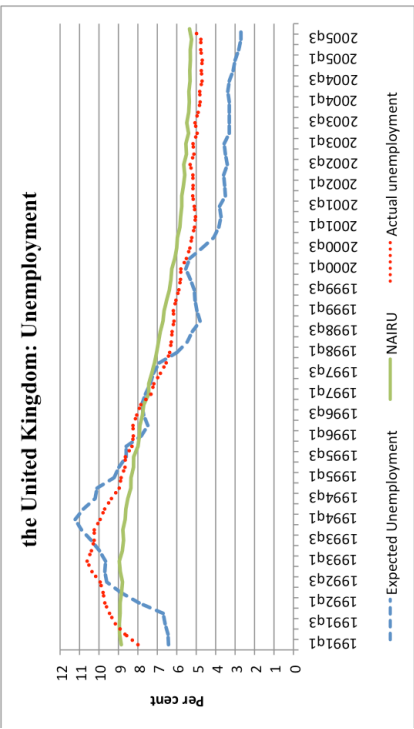
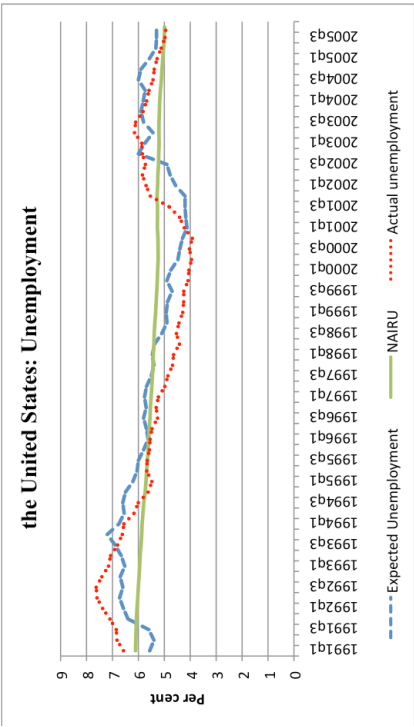
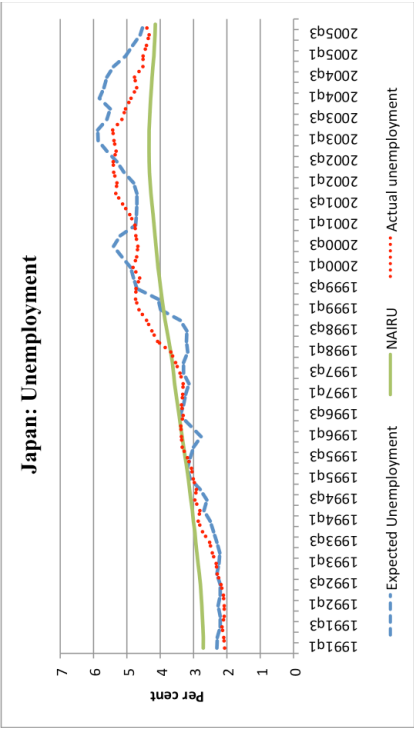


Figure series 3: Unemployment data⁸



⁸ Expected unemployment rate is calculated from the Consensus Economics Inc. data set. Actual unemployment and NAIRU are obtained from the OECD database.



Appendix B: Data

SourceOECD variables.		
	Description	Inventory Code
$Y_{j,t}$	Gross domestic product, volume, market prices	GDPV
$\hat{Y}_{j,t}$	Potential output of total economy, volume ²	GDPVTR
$i_{j,t}$	Short-term interest rate	IRS
$\Pi_{j,t}$	Calculated from the consumer price index ¹	CPI
$U_{j,t}^*$	NAIRU - Unemployment rate with non-accelerating inflation rate	NAIRU
$U_{j,t}$	Unemployment rate	UNR
¹ $\Pi_{j,t} = \ln(CPI_{j,t-4}) - \ln(CPI_{j,t}) * 100$		
² For Norway the potential output did yield the output gap defined by GAP (Output gap of the total economy) as it did for the other countries. Potential output for Norway has been constructed by using the GAP variable.		
Source: OECD (2009b)		